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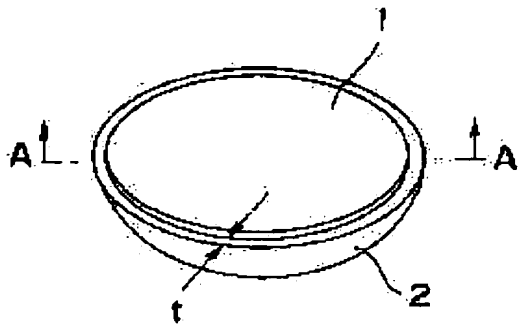
(54) SEMICONDUCTOR WAFER HEATING TOOL AND SEMICONDUCTOR WAFER HEATER USING THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a semiconductor wafer heating plate-like tool, which can uniformly heat a semiconductor wafer without causing slips or defects even if the semiconductor wafer has a large diameter, and a mounter of the tool.
SOLUTION: In a plate-like semiconductor wafer heating tool 2, in which a semiconductor wafer 1 is mounted on the upper face to heat it, the upper face has a circular margin of a diameter having one or more of a wafer to be processed, and also is formed in a recessed curve face shape having the deepest part at the center part, and a difference between heights, namely between a contact point position with a mounted wafer margin and the deepest part is in the range of 20 to 500 μm.



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CLAIMS

[Claim(s)]
[Claim 1] The fixture for semi-conductor wafer heat-treatment characterized by to be in the range whose differences of elevation of a contact location with the wafer periphery which it was formed in the concave bend side configuration have the deepest part, and laid in the center section in the fixture for semi-conductor wafer heat-treatment of the shape of a plate which lays a semi-conductor wafer in the top face, and heat-treats it while said top face had the circular periphery of the diameter more than the diameter of a processed wafer, and said deepest part are 20 micrometers thru/or 500 micrometers.
[Claim 2] The fixture for semi-conductor wafer heat-treatment indicated by claim 1 which the inferior surface of tongue which counters said top face has a concave bend side configuration parallel to a top face, and is characterized by thickness being 1 thru/or 1.5mm.
[Claim 3] The fixture for semi-conductor wafer heat-treatment indicated by claim 1 characterized by being in the range said whose differences of elevation in said top face are 20 micrometers thru/or 200 micrometers, forming mostly in a flat surface the inferior surface of tongue which counters this top face, and being in the range the periphery section thickness of whose is 1.2 thru/or 1.5mm.
[Claim 4] The fixture for semi-conductor wafer heat-treatment indicated by claim 2 or claim 3 characterized by center line average-of-roughness-height Ra in the contact section with the semi-conductor wafer of said top face being in 0.3 thru/or 0.8-micrometer range.
[Claim 5] The fixture for semi-conductor wafer heat-treatment indicated by claim 4 characterized by forming two or more holes penetrated on the inferior surface of tongue from said top face.
[Claim 6] the fixture for semi-conductor wafer heat-treatment according to claim 1 to 5 which laid the processed wafer -- an unit -- or more than one were carried -- It is equipment for semi-conductor wafer heat-treatment for heat-treating said processed wafer. Equipment for semi-conductor wafer heat-treatment using the fixture for semi-conductor wafer heat-treatment characterized by providing the supporter material to which this equipment supports said fixture in the location which separated the one 0.8 times distance [0.6 thru/or] of this of this radius from the inferior-surface-of-tongue central point of said fixture to radial.
[Claim 7] Equipment for semi-conductor wafer heat-treatment using the fixture for semi-conductor wafer heat-treatment indicated by claim 6 characterized by inferior-surface-of-tongue support of said fixture for semi-conductor wafer heat-treatment being mostly performed by three points of a regular-intervals location.
[Claim 8] It has top plating, a bottom plate and this top, and the connection member that separates predetermined spacing and carries out connection immobilization of the ******. So that it may be equipment for semi-conductor wafer heat-treatment which said two or more fixtures which laid the semi-conductor wafer among both plates were carried vertical multistage one, and was supported and said supporter material can support said each fixture according to an individual Equipment for semi-conductor wafer heat-treatment using the fixture for semi-conductor wafer heat-treatment indicated by claim 6 or claim 7 characterized by being projected and prepared in multistage from said connection member.
[Claim 9] Equipment for semi-conductor wafer heat-treatment using the fixture for semi-conductor wafer heat-treatment indicated by claim 8 characterized by for said connection member having consisted of three pillar-shaped members prepared between disc-like ********, and making said supporter material project from each pillar-shaped member.
[Claim 10] Equipment for semi-conductor wafer heat-treatment using the fixture for semi-conductor wafer heat-treatment indicated by claim 6 or claim 7 which is equipment for semi-conductor wafer heat-treatment which holds said fixture which laid the processed wafer and heat-treats this, and is characterized by projecting and forming said supporter material in the top face of a plate-like base material.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the fixture for semi-conductor wafer heat-treatment of the shape of a plate which has the semi-conductor wafer installation top face formed in the detail at the specific configuration, and the equipment for semi-conductor wafer heat-treatment using this more about the equipment for semi-conductor wafer heat-treatment which used the fixture for semi-conductor wafer heat-treatment, and this.
[0002]
[Description of the Prior Art] There are various heating treatment processes, such as oxidation, diffusion, and membrane formation, in the production process of a semiconductor device, and a semi-conductor wafer receives various heat-treatment in it in these processes. And according to the mode of these processings, the class of a heating means to use it, etc., the various fixtures for semi-conductor wafer heat-treatment are used. For example, in the case of the semi-conductor wafer heat treatment process using a vertical mold heat treating furnace, loading maintenance is carried out and semi-conductor wafers, such as two or more silicon single crystal wafers, are processed by a vertical mold multistage wafer maintenance fixture and the so-called vertical mold wafer boat. This vertical mold wafer boat has structure which the stanchion member 10 of the rod configuration in which many slots (slit) 11 for laying a wafer 12 were established arranged to two or more (3 when it is usually 3 or 4, and drawing 6), and a lengthwise direction, as shown in drawing 6 .
[0003] A wafer 12 is supported by two or more of these stanchion members 10 by several points (in the case of drawing 6 three points) of the periphery section, and is heat-treated. Generally as a formation material of this wafer boat, the (Silicon Si) sinking-in silicon carbide of quartz glass and a silicon carbide (SiC) coat, single crystal silicon, polycrystalline silicon, etc. are used.
[0004] Moreover, a semi-conductor wafer is laid in susceptor - of a batch type or single wafer processing which consists of the graphite base material with which the case of the thin film vapor growth process to the wafer side by an epitaxial growth system etc., for example, a SiC coat, was carried out, and predetermined processing is made.
[0005]
[Problem(s) to be Solved by the Invention] By the way, in order that the self-weight of a wafer may concentrate on a supporter, the stress which this produces is always acting on the processed wafer laid in fixtures for semi-conductor wafer heat-treatment, such as a vertical mold wafer boat. And if this stress exceeds critical shear stress, a rearrangement will occur in a wafer. This rearrangement becomes even macroscopic magnitude with breadth and a slip according to an operation of stress. Generating of this slip reduces the quality of a wafer greatly.
[0006] Generally, in critical shear stress, the value becomes small like an elevated temperature, and this means becoming easy to generate a slip of a wafer remarkably under elevated-temperature ambient atmospheres, such as heat treatment, as compared with the time of ordinary temperature. In order to gather the device yield per wafer with high integration of a semiconductor device especially in recent years, diameter-ization of macrostomia of a wafer is progressing. Consequently, the self-weight of a wafer becomes large, it is in the inclination for the stress which acts on a wafer in connection with it to increase, and into a wafer, it is easier to generate a slip and it is coming.
[0007] Moreover, it originates in the size of a wafer other than the above-mentioned reason becoming large, and is in the inclination for the temperature gradient of the wafer core and the periphery section especially at the time of a temperature up to become large, and the thermal stress produced according to this temperature gradient has also become one of the causes of the above-mentioned slip generating. Although the so-called

CZ-silicon wafer manufactured with the Czochrlski method was typical as a base material of a semiconductor device, also among this CZ-silicon wafer, it had the inclination for the slip with which the oxygen density between grids [Oi] generated especially the low oxygen density CZ-silicon wafer between low grids to tend to become large, and the big slip was generated at the time of wafer processing of heat-treatment etc.

[0008] In order to avoid the yield fall of a wafer based on such slip generating, the number of the supporting points of the wafer in said fixture for semi-conductor wafer heat-treatment is increased, the support load per point is decreased, and it can consider making the stress in a supporting point mitigate below to said critical shear stress.

[0009] However, even if it increases the number of the supporting points of the wafer in the fixture for semi-conductor wafer heat-treatment, from problems, such as level precision during each supporting point, in fact, a wafer will be in the condition of supporting in spot with the supporting point of about at most four points, by the above-mentioned approach, concentration of stress still remains and substantial solution is not made.

[0010] Then, how to lay a wafer in the approach of supporting mostly on the whole surface, lay a wafer on the diameter of said and the circular plate of the same thickness mostly with it, and support was able to be considered. Let it be a fundamental concept for this approach to increase a supporting point as much as possible. However, there is irregularity in an actual plate side, a wafer was not able to be substantially supported only by heights, and the purpose of as a result controlling generating of a slip completely was not able to be attained. Moreover, as one of the means to solve this problem, the wafer installation side of a plate plate is finish-machined until the irregularity of this front face is lost nearly completely by mirror polishing etc., and how to lay a wafer in that front face can be considered. However, the wafer and the plate plate stuck firmly at the time of heat-treatment, and it invited new un-arranging [that it became difficult to make a wafer and a plate plate exfoliate].

[0011] this invention person etc. completed this invention for the ability of the above-mentioned problem to be solved certainly based on a header and this knowledge by using the fixture for semi-conductor wafer heat-treatment of the shape of a plate which formed the wafer installation side in the specific configuration so that it might explain in full detail below, as a result of repeating research wholeheartedly about the optimal configuration of the installation side for supporting a wafer in a field, in order to solve the above-mentioned trouble in support fixtures, such as the conventional wafer boat. Moreover, based on a header and this knowledge, this invention was completed for the ability of the above-mentioned problem to be solved certainly with said fixture and the equipment for semi-conductor wafer heat-treatment formed in the specific supporting structure of the member which supports this so that it might inquire wholeheartedly and the optimal gestalt of the approach (member) of carrying plate-like the fixture for semi-conductor wafer heat-treatment, and supporting might be explained in full detail below.

[0012] This invention aims at offering the fixture for semi-conductor wafer heat-treatment which can heat-treat a semi-conductor wafer to homogeneity, and the equipment for semi-conductor wafer heat-treatment using this, without generating a slip and a defect, even if it is the semi-conductor wafer of the diameter of metaphor macrostomia.

[0013]

[Means for Solving the Problem] In the fixture for semi-conductor wafer heat-treatment of the shape of a plate which lays a semi-conductor wafer in the top face, and heat-treats it, while the fixture for semi-conductor wafer heat-treatment of this invention has the circular periphery of the diameter more than the diameter of a processed wafer, said top face The difference of elevation of a contact location with the wafer periphery which it was formed in the concave bend side configuration of having the deepest part, and was laid in the center section, and said deepest part is characterized by being in the range which is 20 micrometers thru/or 500 micrometers.

[0014] It is desirable to form the concave bend side configuration in the top face of the fixture for semi-conductor wafer heat-treatment of the shape of said plate (it may be called a plate-like fixture for short below) in a paraboloidal shape or a concave spherical-surface configuration here. Moreover, when the concave bend side configuration in the wafer installation side of said plate-like fixture is formed in a concave spherical-surface configuration and the radius of curvature (r) of said concave spherical-surface configuration sets the difference of elevation from the contact location of b, this wafer periphery, and an installation side to said deepest part to a for the radius of the wafer to lay, it is r= (b2+a2). It is desirable to have the relation of /2a. Furthermore, it is desirable for center line average-of-roughness-height Ra of the wafer installation side of said plate-like fixture to be 0.3 thru/or 0.8 micrometers.

[0015] Moreover, as for the configuration of this plate-like fixture, it is desirable that the inferior surface of

tongue where said difference of elevation in the thing and said top face of a configuration of the concave curved-surface pan type with which the inferior surface of tongue which counters said top face is parallel to a top face is in the range which is 20 micrometers thru/or 200 micrometers, and counters a top face is mostly formed in a flat surface, and that they are the so-called concave surface and flat-surface mold configuration. When a configuration is concave curved-surface pan type, it is desirable that that thickness is in the range of 1.0mm thru/or 1.5mm, and it is desirable for the error range of the thickness at this time especially to be less than **0.3mm further. Moreover, in the case of a concave surface and a flat-surface mold configuration, especially the thing in the range the periphery section height (periphery section thickness) of whose is 1.2 thru/or 1.5mm is desirable. Moreover, it is desirable to arrange two or more through tubes in the wafer installation side of said plate-like fixture, and it is desirable that the aperture of said through tube is 3mm thru/or 10mm and for the number of said through tubes to be [three pieces thru/or] ten.

[0016] Furthermore, the equipment for semi-conductor wafer heat-treatment of this invention is an unit or equipment for semi-conductor wafer heat-treatment for carrying more than one and heat-treating said processed wafer about the above-mentioned fixture for semi-conductor wafer heat-treatment which lays a processed wafer, and this equipment is characterized by to provide the supporter material which supports a fixture in the location which separated the one 0.8 times distance [0.6 thru/or] of this of this radius from the inferior-surface-of-tongue central point of said fixture to radial. Here, as for the above-mentioned equipment for semi-conductor wafer heat-treatment, it is desirable to support the inferior surface of tongue of a processed wafer installation fixture by at least three points. Especially the thing for which at least three points which support said plate-like fixture on a base are located mostly at equal intervals is desirable.

[0017] Moreover, said equipment for semi-conductor wafer heat-treatment is equipped with top plating, a bottom plate and this top, and the connection member that separates predetermined spacing and carries out connection immobilization of the ******. So that it may be equipment for semi-conductor wafer heat-treatment which said two or more fixtures which laid the semi-conductor wafer among both plates were carried vertical multistage one, and was supported and said supporter material can support said each fixture according to an individual It is desirable that it is equipment for semi-conductor wafer heat-treatment projected and formed in multistage from said connection member. Moreover, especially the thing that said connection member in the equipment for semi-conductor wafer heat-treatment of said vertical mold wafer boat format consists of three pillar-shaped members prepared between disc-like ********, and is made for said supporter material to project from each pillar-shaped member is desirable. Furthermore, it is desirable that it is susceptor - the equipment for semi-conductor wafer heat-treatment with which it is equipment for semi-conductor wafer heat-treatment with which said equipment for semi-conductor wafer heat-treatment holds said fixture which laid the processed wafer, and heat-treats this, and said supporter material was projected and formed in the top face of a plate-like base material, i.e., the so-called batch type, and for single-wafer-processing semi-conductor wafer processors.

[0018] It is the remarkable description that it is the plate for wafer installation which has the specific wafer installation side that the plate-like fixture for semi-conductor wafer heat-treatment concerning this invention is formed in a center section at the concave bend side configuration to have the deepest part while it has a diameter beyond the optimal wafer installation side, i.e., the diameter of an installation wafer, in order to support a wafer in a field, and it is in the range whose differences of elevation from a contact location with an installation wafer periphery to the deepest part are 20 thru/or 500 micrometers.

[0019] For example, when a periphery supports a wafer in respect of specific concave bend side configuration installation of a circular paraboloidal shape or a concave spherical-surface configuration, the periphery section and this installation side of a wafer contact first. And the laid wafer bends with a self-weight and the center section also comes to touch an installation side center section by sinking slightly. By this, a wafer is supported by coincidence in both an installation side periphery and the center section, and can ease concentration of stress.

[0020] Since in the case of the above wafer support modes a wafer is wide range and it is supported, a slip is not generated. That is, in this invention, especially the thing in the range whose differences of height with the wafer periphery contact location of a center section (deepest part) and the installation side periphery of that the installation side of the plate-like fixture for wafer installation is formed in a concave bend side configuration and a wafer installation side are 20 thru/or 500 micrometers is important. If this difference exceeds 500 micrometers, although a wafer will not bend, since the center section of a wafer cannot reach even an installation side, it becomes support of only the periphery section, and it is easy to generate a slip from there. Moreover, this difference will support some of center sections of a wafer, or a center section and specific wafers in less than 20 micrometers, and a slip is generated from there.

[0021] Moreover, the above-mentioned slip generating can be prevented more certainly, a wafer and a plate cannot stick at the time of heat-treatment, but a wafer can be made to exfoliate easily in the fixture for semi-conductor wafer heat-treatment of this invention by making center line average-of-roughness-height Ra (JIS B0601-1994) of the installation side of said plate-like fixture into 0.3 thru/or the range of 0.8 micrometers. Moreover, it can prevent that a wafer breaks at the time of exfoliation by making roughness into this range.
[0022] Moreover, it has the advantage which prevents adhesion of both from whom 3 thru/or the thing of a mode arranged ten pieces produce the through tube whose aperture is 3 thru/or about 10mm when the gap of an installation wafer and a plate will be in a vacua at the time of heat-treatment to the installation side of a plate-like fixture.
[0023] Furthermore, especially in the case of the fixture of a mode of said plate-like fixture with which an installation side consists of silicon (Si) at least, by not damaging a wafer, since physical properties, such as a wafer, coefficient of thermal expansion, and a degree of hardness, are the same when an installation wafer is a silicon wafer, in being especially single crystal silicon, it is a high grade and there is no problem of contamination. Moreover, what the inferior surface of tongue which counters the top face of a plate-like fixture has a concave bend side configuration parallel to a top face, and has the thickness of this plate material in 1.0 thru/or the range of 1.5mm has sufficient support reinforcement, without causing deformation etc., also when a wafer is laid and heated on [other than the above-mentioned advantage] a plate. Especially, since heat capacity is not excessive, either, heat transfer is also quick, and since the temperature up of the wafer can be carried out to homogeneity without temperature nonuniformity at the time of heating, slip generating of a wafer based on temperature distortion can be controlled. if it is in the range whose differences of elevation in the top face of a plate fixture are 20 micrometers thru/or 200 micrometers on the other hand and an inferior surface of tongue is one of those which were mostly formed in the flat surface -- the heterogeneity of heat transfer to the difference of elevation -- comparatively -- being small (200 micrometers) -- it is necessary to stop
[0024] Furthermore, in said plate-like fixture and its base, the equipment for semi-conductor wafer heat-treatment with which said three supporting points be locate in radial from the inferior surface of tongue core of a plate-like fixture as 0.6 thru/or 0.8 times as many ******** as this of this radius with the equipment for semi-conductor wafer heat-treatment support by at least three points have the advantage which can control the wave status change form in the periphery section of the installation wafer often produced conventionally by supporter material again. In the case of less than 0.6 times of this radius, a supporting section becomes from the inferior-surface-of-tongue core of a plate-like fixture with the letter of a projection radial, and it becomes support of only this part, and becomes easy to generate a slip to a wafer. On the other hand, when 0.8 times of this radius are exceeded from the inferior-surface-of-tongue core of a plate-like fixture to radial, this plate bends too much, and it mainly becomes support of only the wafer circumference, and becomes easy to generate a slip. Moreover, when the equipment for semi-conductor wafer heat-treatment is the so-called vertical mold wafer boat format, a wafer installation plate fixture can be carried in multistage, and many wafers can be heat-treated good at once, without producing the defect of a slip etc. Moreover, a plate-like fixture is applicable also to batch type or single-wafer-processing susceptor -.
[0025] The plate-like fixture for semi-conductor wafer heat-treatment of this invention is applicable effective in heat-treatment of the oxygen density silicon wafer between low grids said especially to be easy to generate a slip in the time of heat-treatment etc.
[0026]
[Embodiment of the Invention] Below, this invention is explained to a detail based on drawing. Drawing 1 is the perspective view having exaggerated and shown 1 operation gestalt of the plate-like fixture concerning this invention, drawing 2 (a) and (b) are drawings having shown the condition of having laid the processed wafer in the plate-like fixture of drawing 1 , and (b) is [(a) is the sectional view showing the condition of the wafer immediately after installation, and] the sectional view showing the change of state of the wafer under heating. Drawing 3 is the perspective view having exaggerated and shown other 1 operation gestalten of the plate-like fixture of this invention. Drawing 4 is drawing having shown the equipment for semi-conductor wafer heat-treatment concerning this invention which multistage-carried the plate-like fixture of this invention which laid the semi-conductor wafer which should be heat-treated, and was supported in the mode held in the furnace. The mode which held in the furnace the equipment for semi-conductor wafer heat-treatment concerning this invention of single wafer processing which supported the singular plate-like fixture by three supporter material shows drawing 5 (a) and (b), (a) shows the side elevation and (b) shows a top view. Moreover, drawing 6 shows the conventional vertical mold wafer boat which supports a semi-conductor wafer. Furthermore, the perspective view having shown the support which constitutes the semi-

conductor wafer heat treatment equipment concerning this invention with which the plate-like fixture of this invention carries out multistage loading support of drawing 7 , Single wafer processing to which drawing 8 supported the singular plate-like fixture by ring-like supporter material, The sectional view having shown the semi-conductor wafer thermal treatment equipment concerning this invention, the top view of this equipment that showed drawing 9 to drawing 8 R> 8, and drawing 10 are the semi-conductor wafer heat treatment equipments concerning this invention which made ring-like supporter material the shape of horseshoe shape.

[0027] The plate-like fixture for semi-conductor wafer heat-treatment of this invention is formed so that it may be formed in a center section at the concave bend side configuration of having the deepest part and may become the range whose differences of elevation a from a contact location with an installation wafer periphery to said deepest part are 20 thru/or 500 micrometers, while the wafer installation side (top face) has the periphery diameter D more than diameter 2b (radius b) of the processed wafer laid, as shown in drawing 1 and drawing 2 .

[0028] When a processed wafer is laid in this wafer installation side, as it is shown in drawing 2 (a), if a wafer 1 contacts an installation side, and is supported in that periphery section and it heat-treats in this condition, a center section will bend slightly with that self-weight, and will sink from the periphery section, the center section that center section of whose is the deepest part of the plate-like fixture 2 will be touched, and it will be supported in respect of [whole] this concave bend (drawing 2 (b)).

[0029] A wafer receives heat from both by the side of an inferior surface of tongue and a top face, when heated within a thermal treatment equipment. By the differential thermal expansion by this, since there are many inferior-surface-of-tongue sides a little, although the heating value has the very few peripheries of a wafer, it usually has the inclination to curve up. Support of the concave bend side by said plate-like fixture 2 uses such a property of said wafer.

[0030] The wafer installation side of the plate-like fixture 2 of this invention is formed in the configuration which suited the natural deformation at the time of heat-treatment of the above-mentioned wafer. From the above-mentioned purpose, the configuration of this wafer installation side will not be especially limited, if it is the concave bend side configuration of having the deepest part in the center section. For example, although it is formed in the concave bend side configuration of arbitration and does not interfere, you may be the paraboloidal shape in which a concave bend side is formed by rotating a parabola, the concave spherical-surface configuration formed by rotating a circle.

[0031] Especially a desirable concave bend side configuration is r= (b2+a2), when the radius of curvature (r) sets the difference of elevation from a contact location with the installation side of b and this wafer periphery to an installation **** concave point to a for the radius of an installation wafer, as shown in drawing 2 (a). It is formed in the shape of [which has the relation of /2a] the concave spherical surface.

[0032] It is [in / at this invention / the concave bend side configuration of the above-mentioned wafer installation side] important 20 thru/or that the difference of elevation from a contact location with an installation wafer periphery to the deepest part carries out a configuration setup as there are 500 micrometers in the range of 50 thru/or 350 micrometer** more preferably. When this difference of elevation exceeds 500 micrometers, the center section of a wafer cannot reach the center section which is the deepest part of said installation side, and cannot serve as support of only a wafer periphery substantially, and slip generating of the wafer which is the purpose of this invention cannot fully be prevented. On the other hand, when the difference of elevation is less than 20 micrometers, the case where the curvature at the time of heating of a wafer exceeds the difference of elevation cannot arise, it cannot become a wafer center section or a center section, and support only at a periphery partial point, and the purpose of this invention cannot fully be attained in this case. In addition, said wafer installation side is radius-of-curvature r= (b2+a2). When formed in the shape of [which has the relation of /2a] the concave spherical surface, radius of curvature is set to 56.25 thru/or 562.5m with the diameter (300mm) of 12 inches of processed wafers.

[0033] As for the part which touches an installation wafer in the installation side (top face) of said plate-like fixture of this invention, it is desirable to be formed in the range whose center line average-of-roughness-height Ra (JIS B0601-1994) which is the surface roughness is 0.3 thru/or 0.8 micrometers. When the center line average of roughness height is less than 0.3 micrometers, a wafer and an installation side tend to stick at the time of heat-treatment, and it becomes difficult to make a wafer exfoliate from a plate-like fixture. When the center line average of roughness height exceeds 0.8 micrometers, support in the installation side contact section of a wafer turns into support of only the convex point of a split face, and causes slip generating.

[0034] moreover -- although not illustrated -- the wafer installation side of the plate-like fixture of this invention -- aperture -- 3 -- or it is especially preferably desirable 3 thru/or to distribute and arrange

especially 5 thru/or ten 8mm through tubes in homogeneity in 4 thru/or seven pieces, and a field preferably 10mm. The plate-like fixture of the mode which prepared the above-mentioned through tube can prevent both adhesion produced when the gap of an installation wafer and a plate will be in a vacua at the time of heat-treatment.

[0035] When the aperture of said through tube 3 is larger than 10mm, or when there are many holes from ten pieces, it becomes easy to cause increase of the temperature unevenness at the time of the fall of the plate-like fixture itself on the strength, or wafer heating. Moreover, when the through tube has been arranged in the wafer installation side at the ununiformity, the fall of a plate-like fixture on the strength is caused, and when arranged in the mode to which three or more through tubes are located in a line on the same straight line of the radius vector direction of a wafer side, the fall of a plate-like fixture on the strength is caused similarly. When, as for this, the same force acts by the cross section becoming small in the field if a hole is located in a line on the same straight line, since the cross section becomes small, stress becomes large. Since bending is proportional to stress, it will be greatly bent by the above-mentioned conditions after all.

[0036] Especially if configurations other than a wafer installation side of the above-mentioned plate-like fixture used by this invention are configurations which can be carried in the equipment for semi-conductor wafer heat-treatment of this invention, they are not limited, and they may be suitably set up according to the equipment structure of carrying this plate. A concave bend side configuration is formed in the plate fixture 2 of a concave curved-surface pan type configuration (cup configuration) as shown in drawing 1 , and a top face as shown in drawing 3 as an appearance configuration of such a plate-like fixture, and the plate for wafer installation of a concave surface and a flat-surface mold configuration with an even base etc. can be illustrated.

[0037] From a viewpoint which carries out the heating temperature up of the wafer to homogeneity without temperature nonuniformity at the time of heat-treatment, it has the proper cross-section thickness t with a component almost equal at the whole plate, and the plate fixture 2 of the cup configuration (pan form) which is not excessive is desirable. In the case of the fixture (fixture shown in drawing 3) of a concave surface and a flat-surface mold configuration, in the periphery section of a fixture, and an inside inner, since there is a difference of heat capacity based on a difference of the thickness a little, when a semi-conductor wafer is laid and heat-treated to this, some heterogeneity may be produced in distribution whenever [Men internal temperature / of a wafer]. for this reason, in the case of the plate-like fixture (fixture shown in drawing 3) of the above-mentioned concave surface and flat-surface mold configuration The concave bend side configuration on the top face of a fixture is formed so that the difference of elevation of the contact location of an installation wafer periphery and the deepest part may be set to 20 thru/or 200 micrometers. And it is desirable to form the periphery section height (thickness) of this fixture so that the thickness of fixture center-section meat may be set to 1mm or more, in order to prevent 1.2 thru/or 1.5mm, i.e., deformation. Moreover, as an ingredient which constitutes a plate-like fixture, the (Silicon Si) sinking-in silicon carbide of the ingredient usually used for this kind of fixture, for example, quartz glass, and a silicon carbide (SiC) coat, single crystal silicon, polycrystalline silicon, CVD-SiC film material, etc. can be mentioned. Among these, silicon is desirable and especially single crystal silicon is desirable. Especially, when a processed semi-conductor wafer is a silicon wafer, since physical properties, such as coefficient of thermal expansion and a degree of hardness, are the same, it makes [do not damage a wafer and] pollute and is desirable [a part for a wafer installation surface part at least / the thing of the plate-like fixture 2 currently formed with the silicon single crystal]. In addition, from especially the viewpoint of coefficient of thermal expansion, it is most desirable that it is a silicon single crystal simple substance.

[0038] Moreover, when the formation ingredient consists of silicon, as for especially the plate-like fixture 2 shown in drawing 2 , it is desirable [cross-section thickness t of plate material] that it is in 1.0 thru/or the range of 1.5mm. When the thickness of a plate-like fixture is less than 1.0mm and the plate-like fixture 2 is supported with the support of a vertical mold wafer boat format, the supported part and its circumference rise and said wafer installation side is made to produce local irregularity. Consequently, the wafer which said irregularity laid is touched and a wafer is made to generate a slip. On the other hand, when thickness exceeds 1.5mm, the heat capacity of a plate-like fixture becomes large and it becomes easy to produce ununiformity-ization whenever [Men internal temperature / of a wafer]. In addition, in the case of the plate fixture 2 of the concave surface and flat-surface mold configuration shown in drawing 3 , the above-mentioned plate fixture makes thickness t of the thinest part, i.e., a field center section, the above-mentioned cross-section thickness.

[0039] The plate-like fixture which laid the processed wafer is supported with the support which has

predetermined supporter material, constitutes the equipment for semi-conductor wafer heat-treatment of this invention, and is held in this equipment. In this invention, especially if the support which holds a plate-like fixture is equipment equipped with the support means which supports this plate-like fixture, it is not limited, and it may be suitably chosen according to the processing purpose of a wafer.

[0040] For example, in the case of processors, such as an epitaxial growth system, the susceptor 4 which holds the plate fixture 2 for wafer installation supported on letter supporter material of projection 4a as shown in drawing 5 (a) and (b) in bell jar 4b can be mentioned. That is, on a susceptor -4, plate supporter material 4a of three letters of a projection is prepared, and the plate fixture 2 of the cup mold (pan type) shown in drawing 1 is carried on the plate supporter material 4a. Said projection 4a is formed in the object with spacing of 120 degrees to the core of the plate fixture 2 for wafer installation.

[0041] In the case of the equipment for semi-conductor wafer heat-treatment possessing the support fixture of the format of on the other hand carrying two or more wafers like a vertical mold wafer boat in multistage, what equipped multistage with the support means of a plate-like fixture as shown in drawing 4 can be illustrated. The support 5 of the shape of a vertical mold wafer boat shown in drawing 4 is equipped with double-width plate supporter material 5b projected from this stanchion (connection member) 5a. Multistage installation of said plate-like fixture is carried out at said plate supporter material 5b. In addition, drawing 4 is the side-face sectional view of the heat treating furnace of a vertical mold, six in drawing shows a reactor core tube, and 7 shows the heater.

[0042] When supporting a plate-like fixture with the plate supporter of support, in the base, it is desirable to be supported by the core of the plate-like fixture 2 by at least three points which are symmetry, and it is desirable that these especially three supporting points are located in radial from the core of a wafer installation plate-like fixture as 0.6 thru/or 0.8 times as many ******** as this of this radius. By supporting a plate-like fixture as mentioned above, generating of the wave status change form in the periphery section of the plate for wafer installation can be conventionally controlled in the fixture for semi-conductor wafer heat-treatment.

[0043] Moreover, it changes to letter supporter material of projection 5b shown to drawing 4 that it described above, and it is good also as supporter material 5c of the shape of a ring as shown in drawing 7 , and supporter material may be formed in the shape of notching **** horseshoe shape for a part of supporter material 5c of the shape of said ring. In addition, the supporter material of the shape of said ring is applicable to drawing 8 and the thermal treatment equipments of single wafer processing as shown in 9. That is, ring-like supporter material 8a may be prepared in the top face of a base 8, and the plate-like fixture 2 may be laid. Drawing 8 is the A-A sectional view of drawing 9 , and drawing 9 is a top view. Moreover, as shown in drawing 10 (a) and (b), supporter material may be formed in the shape of notching **** horseshoe shape for a part of supporter material 8a of the shape of said ring. at this time, it is shown in drawing 10 (a) -- as -- the magnitude of that notch part -- that central angle -- 30 degrees or less have desirable theta. This is for making it temperature not become an ununiformity to the inside of a wafer side, said 30 degrees are maximum and 10 degrees or less are more preferably good.

[0044] Moreover, since the thing small as much as possible of the heat capacity of the supporter material which this fixture contacts is desirable, supporter material has the desirable cylindrical configuration of a circular cross section, and, as for a plate fixture and supporter material, making as [become / point contact] is desirable [as described above, especially the configuration of supporter material is not limited, but]. Although three or more points are sufficient as the number of supporting points, three are desirable, in order in the case of an end-fire array boat format only for the part to increase the number of a rod-like connection member and to cause increase of cost. Moreover, in the case of single wafer processing, the supporting point of three or more points may be prepared, but on supporter material or plate-like dimensional accuracy, since it becomes three-point support after all, three-point support is desirable.

[0045] Moreover, although the single crystal silicon wafer produced from a single-crystal-silicon ingot is typical as a base material of a semiconductor device Also among this silicon wafer, the oxygen density between grids [Oi] especially the low oxygen density CZ-silicon wafer between low grids ([Oi] concentration is usually 1.3x1018 atoms/cm3 (old ASTM) following) Having the inclination for the slip which was easy to carry out especially slip generating, and was generated at the time of wafer processing of heat-treatment etc. to tend to become large is known. The plate-like fixture for semi-conductor wafer heat-treatment of this invention can be applied especially effective in heat-treatment of such an oxygen density CZ-silicon wafer between low grids.

[0046]

[Example] After starting from a "example 1" silicon single crystal ingot, by polish processing and etching

processing by the grinder, the periphery equipped circular and a center section with the wafer installation side (top face) of the **** curved-surface configuration of having the deepest part, the plate-like fixture of a concave surface and a flat-surface mold configuration as an inferior surface of tongue shows to plane drawing 3 was produced, and this plate-like fixture was washed using aqueous ammonia and the wash water which consists of a hydrogen peroxide. In addition, the difference of elevation from a contact location with 303mm and a wafer periphery to the deepest part of the diameter of the wafer installation side (top face) of this plate-like fixture was 1.2mm in 20 micrometers, center line average-of-roughness-height Ra0.5micrometer of a wafer installation side, and periphery section thickness of a fixture. Moreover, six pieces were formed at intervals of 60 degrees, and seven through tubes were formed in the radius 0.65 times the location of the core in total in the wafer installation side. The sample wafer shown below was prepared and it laid on the installation side (top face) of the above-mentioned plate-like fixture at the condition which shows in drawing 3 (b). As a sample wafer, the diameter of 300mm, field bearing [100], P type, and the silicon single crystal wafer of resistance rho= 9 - 14 ohm-cm were used. in addition, the oxygen [Oi] concentration between grids which measured this sample wafer in advance by infrared absorption spectrometry -- 1.1 - 1.2x1018 atoms/cm3 (old ASTM) it was .

[0047] 25 plate-like fixtures which laid the above-mentioned sample wafer were carried in the support (vertical mold wafer boat) supported to lengthwise direction multistage. Moreover, it laid three dummy wafers at a time in the vertical edge of this support fixture respectively. Said support fixture is equivalent to what was shown in drawing 4 , and the thing of a three-point support type was used for it by the product made from silicon. In addition, the slit (supporter material) is formed for a long time so that it may support at this core from a core at one 0.8 times the location of a radius and this support fixture may support the bottom surface part of said plate-like fixture in which the wafer was laid by three points to the symmetry.

[0048] The wafer was heat-treated using the equipment for semi-conductor wafer heat-treatment which carried the above-mentioned sample wafer installation plate-like fixture in the above-mentioned support, and the slip generating situation in that case was evaluated. In addition, after ******(ing) at 700 degrees C, the temperature up of the heat treatment was carried out to 1000 degrees C by 8 degrees C / min, and after that, it was held in a temperature up and this 1200-degree C condition to 1200 degrees C by 2 degrees C / min for 1 hour, was lowered to 1000 degrees C by 2 degrees C / min, and was performed by the sequence which lowers the temperature and **** to 700 degrees C by 8 degrees C / min after that. In addition, hydrogen gas was made to flow by 20 l/min in a furnace, and it considered as the hydrogen ambient atmosphere. Measurement evaluation of the slip generating condition of the sample wafer after the above-mentioned heat treatment was carried out using X-line topography (lang law). In addition, at X-line target, it measured about all 25 sheets using Mo by the acceleration voltage of 55kV, and the operating condition of 290mA of currents. The diffraction side was made into 400 diffraction which is most suitable for slip observation. The evaluation result is shown in Table 1 and drawing 11 R> 1. In addition, in any case, the difference in some was in the location of a slip, but since most of 25 sheets were in the same slip generating situation, the example was shown in drawing 11 .

[0049] The difference of elevation from a contact location with the wafer periphery in a "examples 2 and 3" wafer installation side to the deepest part 140 micrometers (example 2), It is 200 micrometers (example 3). Periphery section thickness 1.3mm (example 2), The plate-like fixture produced like the example 1 is used except being 1.5mm (example 3). After laying the plate-like fixture like the example 1 in the support of the same vertical mold wafer boat format as an example 1 and heat-treating like an example 1 to it, measurement evaluation of the slip generating condition of a wafer was carried out. The evaluation result is shown in Table 1 and drawing 1111 .

[0050] Start from the same silicon single crystal ingot with having used it in the "example 1 of comparison" example 1, and by polish processing and etching processing by the grinder A top and an inferior surface of tongue are the plate-like fixture for disc-like wafer installation of an parallel flat surface (0.9mm in thickness) mutually. After having manufactured top-face center line average-of-roughness-height Ra0.5micrometer, laying this in the same support as an example 1 like the example 1 and heat-treating like an example 1, measurement evaluation of the slip generating condition of a wafer was carried out. The result is shown in Table 1 and drawing 11 .

[0051] Except that the difference of elevation from a contact location with the wafer periphery in the "example 2 of comparison" wafer installation side to the deepest part was 1.7mm in 220 micrometers and periphery section thickness, after carrying like the example 1 in the same support as an example 1 and heat-treating similarly to it using the plate-like fixture produced like the example 1, measurement evaluation of the slip generating condition of a wafer was carried out. The evaluation result is shown in Table 1 and

drawing 11 .

[0052] From the same silicon single crystal ingot as the "example 4" example 1, the plate-like fixture of the concave curved-surface pan type configuration of having the curve concave surface-like inferior surface of tongue which a periphery equips circular and a center section with the top face of the concave bend side configuration of having the deepest part, and is parallel to this top face was produced, and this fixture was washed using the wash water which consists of aqueous ammonia and a hydrogen peroxide. In addition, the difference of elevation from a contact location with 303mm and a wafer periphery to the deepest part of the diameter of the top face (wafer installation side) of this plate-like fixture was 1.0mm in 20 micrometers, center line average-of-roughness-height Ra0.5micrometer of a wafer installation side, and thickness. Except having supported the fixture bottom surface part from the core three symmetry to the same support as an example 1 at one 0.6 times the location of a radius using this plate-like fixture, after laying like the example 1 and heat-treating like an example 1, measurement evaluation of the slip generating condition of a wafer was carried out. The evaluation result is shown in Table 1 and drawing 11 R> 1.

[0053] Except being the "examples 5 and 6" difference of elevation, thickness, and the value that top-face core average-of-roughness-height Ra indicated to Table 1, respectively, the same concave curved-surface pan type plate-like fixture as an example 4 was produced, and measurement evaluation of the slip generating condition of a wafer was carried out for this like the example 4. The evaluation result is shown in Table 1 and drawing 11 .

[0054] The same concave curved-surface pan type plate-like fixture as an example 4 is produced except being the example 3 of a comparison thru/or "7" differences of elevation, thickness, and the value that top-face center line average-of-roughness-height Ra indicated to Table 1, respectively. A fixture bottom surface part is laid in the fixture loading equipment of a vertical mold wafer boat format like an example 4 from a core except having supported in the multiple location of the radius indicated to Table 1, respectively. (-- however, after heat-treating only the example 5 of a comparison like 4 point-symmetry support) and an example 4, it carried out measurement evaluation of the slip generating condition of a wafer. The evaluation result is shown in Table 1 and drawing 11 .

[0055] Except being 1.0mm in "example 8 of comparison" periphery section thickness, except having supported the fixture bottom surface part from the core three symmetry to the same support as an example 1 at one 0.6 times the location of a radius using the plate-like fixture produced like the example 1, after laying like the example 1 and heat-treating like an example 1, measurement evaluation of the slip generating condition of a wafer was carried out. The evaluation result is shown in Table 1 and drawing 11 .

[0056]

[Table 1]

	支持方式		下面形状	高低差（μm）	厚さ（mm）	Ra（μm）	スリップ発生状況
	支持点数	支持位置					
比較例1	3	0．8	平面	0（フラット）	0．9	0．5	図7比1
実施例1	3	0．8	平面	20	1．2	0．5	図7実1
実施例2	3	0．8	平面	140	1．3	0．5	図7実2
実施例3	3	0．8	平面	200	1．5	0．5	図7実3
比較例2	3	0．8	平面	220	1．7	0．5	図7比2
実施例4	3	0．6	湾曲面	20	1．0	0．5	図7実4
実施例5	3	0．6	湾曲面	350	1．3	0．5	図7実5
実施例6	3	0．6	湾曲面	500	1．5	0．5	図7実6
比較例3	3	0．6	湾曲面	550	1．8	0．5	図7比3
比較例4	3	0．5	湾曲面	350	1．3	0．5	図7比4
比較例5	4	1	湾曲面	350	1．3	0．5	図7比5
比較例6	3	0．6	湾曲面	350	1．3	0．1	図7比6
比較例7	3	0．6	湾曲面	350	1．3	1．0	図7比7
比較例8	3	0．6	平面	0（フラット）	1．0	0．5	図7比8

[0057] In the examples 1-3 of an example, the slip of 1-2 was observed by the periphery of a wafer in 10-13

sheets among 25 processed wafers so that clearly from drawing 11 . However, the slip of 10mm or more was not observed at all. In addition, the slip was observed at all by neither of the remaining processed wafer. Moreover, in the examples 4-5, the slip was not observed at all about all the 25 processed wafers. On the other hand, in the examples 1-5 of a comparison, and 7 and 8, several parts to which a slip of 10mm or more exists in high density in the periphery of a wafer were observed. Moreover, in the example 6 of a comparison, the cleavage was observed in the abbreviation diameter direction of a wafer. As mentioned above, in the example, it was admitted that can have the wafer installation side of a specific configuration, can prevent generating of the defect of a slip etc. in a wafer since a processed wafer is laid and heat-treated to this, or it could control.

[0058]

[Effect of the Invention] The fixture for semi-conductor wafer heat-treatment of this invention is equipped with the wafer installation side of the specific configuration mentioned above, since a processed wafer is laid and heat-treated to this, when carrying out elevated-temperature heat treatment of the wafer of the diameter of metaphor macrostomia, the defect of a slip etc. cannot be generated in a wafer, and is stabilized and can manufacture the semiconductor device of good quality with the sufficient yield.

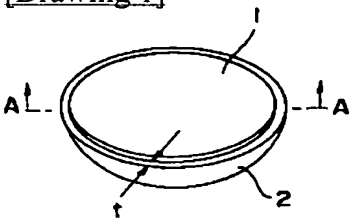
[Translation done.]

* NOTICES *

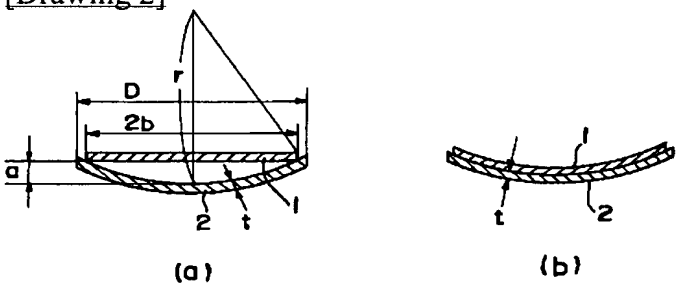
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

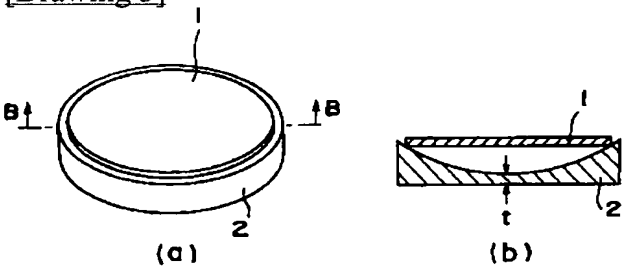
[Drawing 1]



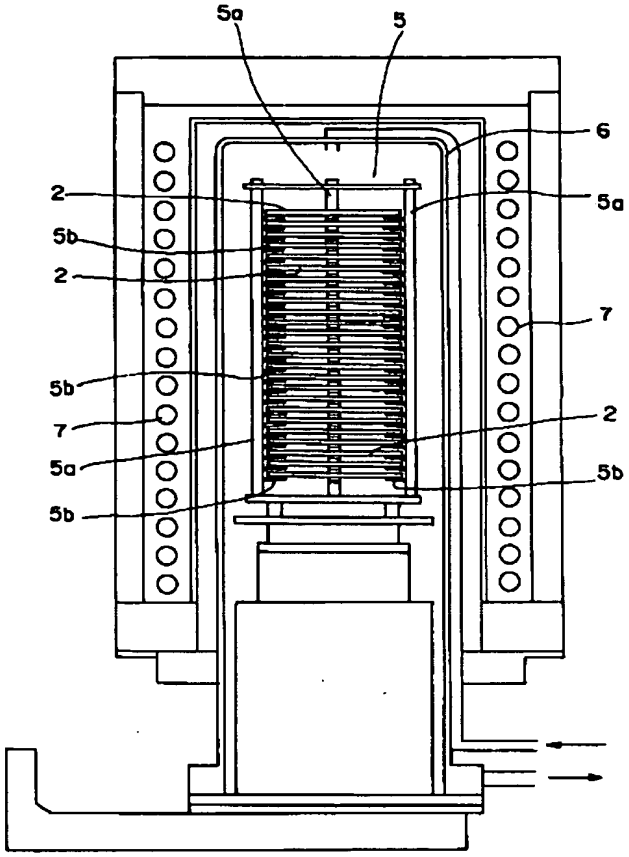
[Drawing 2]



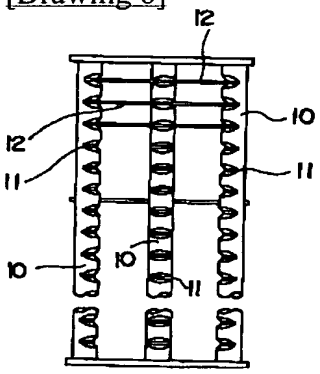
[Drawing 3]



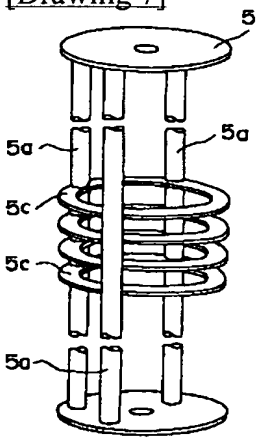
[Drawing 4]



[Drawing 6]

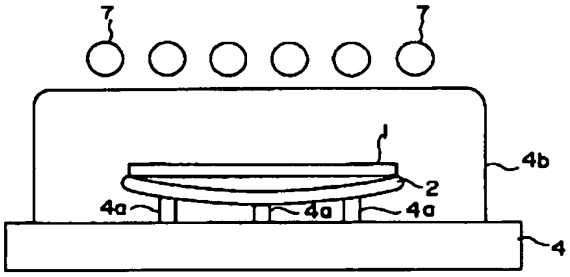


[Drawing 7]



[Drawing 5]

(a)



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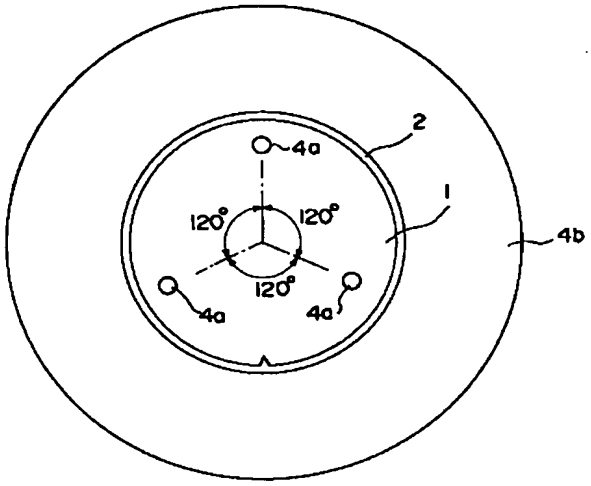
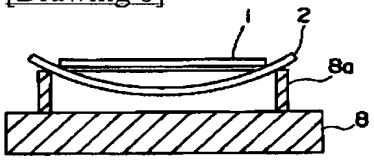
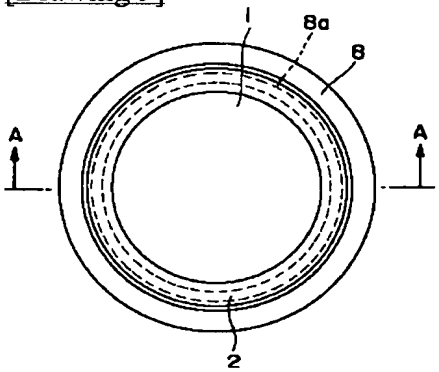


[Drawing 8]

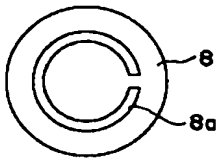


[Drawing 9]



[Drawing 10]

(a)



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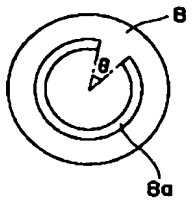
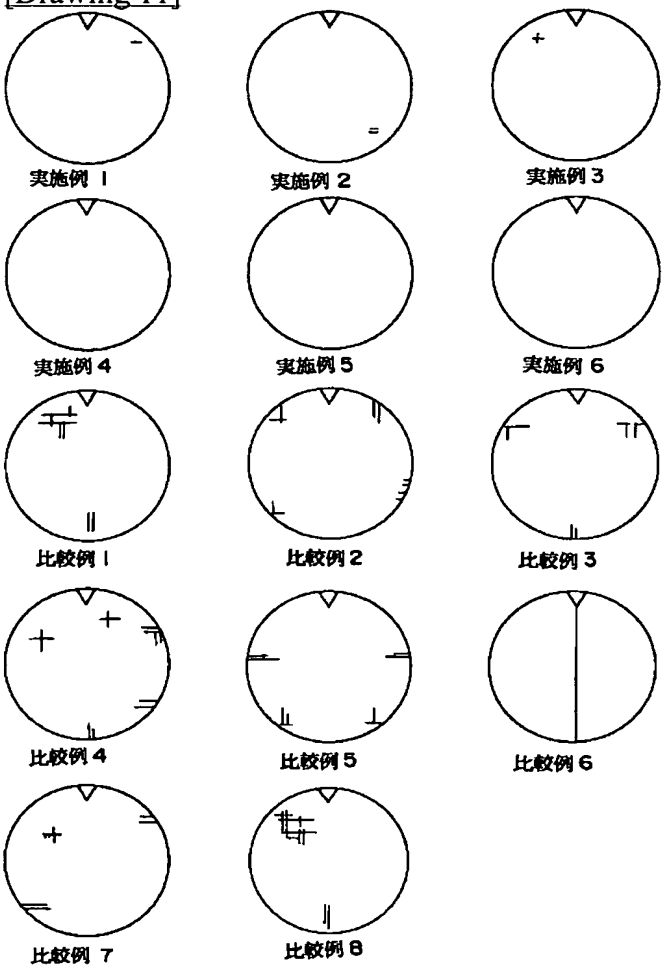


[Drawing 11]



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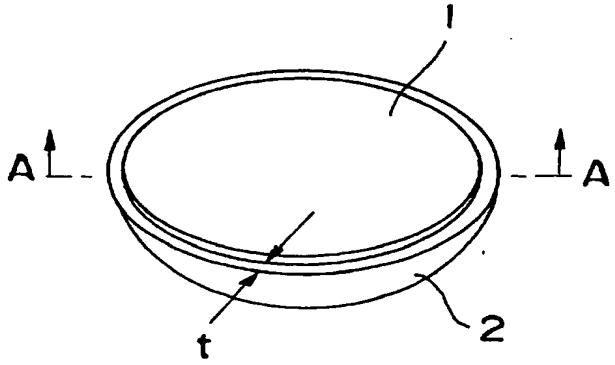
最終頁に続く

(54)【発明の名称】　半導体ウエハ加熱処理用治具及びこれを用いた半導体ウエハ加熱処理用装置

(57)【要約】
【課題】　大口径の半導体ウエハであっても、スリップや欠陥を発生させることなく半導体ウエハを均質に加熱処理することができる半導体ウエハ加熱処理用のプレート状治具及びその治具の搭載装置を提供する。
【解決手段】半導体ウエハ１を、その上面に載置して加熱処理するプレート状の半導体ウエハ加熱処理用治具２において、前記上面が、被処理ウエハの直径以上の直径の円形周縁を有すると共に、中央部に最深部を有する凹曲面形状に形成され、載置したウエハ周縁との接点位置と前記最深部との高低差が２０μm乃至５００μmの範囲にあることを特徴とする。



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【特許請求の範囲】

【請求項１】　半導体ウエハを、その上面に載置して加熱処理するプレート状の半導体ウエハ加熱処理用治具において、

前記上面が、被処理ウエハの直径以上の直径の円形周縁を有すると共に、中央部に最深部を有する凹曲面形状に形成され、載置したウエハ周縁との接点位置と前記最深部との高低差が２０μｍ乃至５００μｍの範囲にあることを特徴とする半導体ウエハ加熱処理用治具。

【請求項２】　前記上面に対向する下面が、上面と平行な凹曲面形状を有し、厚さが１乃至１．５ｍｍであることを特徴とする請求項１に記載された半導体ウエハ加熱処理用治具。

【請求項３】　前記上面における前記高低差が２０μｍ乃至２００μｍの範囲にあり、該上面に対向する下面が、ほぼ平面に形成され、その周縁部厚さが１．２乃至１．５ｍｍの範囲にあることを特徴とする請求項１に記載された半導体ウエハ加熱処理用治具。

【請求項４】　前記上面の半導体ウエハとの接触部における中心線平均粗さＲａが０．３乃至０．８μｍ範囲にあることを特徴とする請求項２又は請求項３に記載された半導体ウエハ加熱処理用治具。

【請求項５】　前記上面から下面に貫通する複数の孔が形成されていることを特徴とする請求項４に記載された半導体ウエハ加熱処理用治具。

【請求項６】　被処理ウエハを載置した請求項１乃至５のいずれかに記載の半導体ウエハ加熱処理用治具を単数もしくは複数搭載した、前記被処理ウエハを加熱処理するための半導体ウエハ加熱処理用装置であって、

該装置が、前記治具の下面中心点から半径方向に、該半径の０．６乃至０．８倍の距離を隔てた位置で前記治具を支持する支持部材を具備することを特徴とする半導体ウエハ加熱処理用治具を用いた半導体ウエハ加熱処理用装置。

【請求項７】　前記半導体ウエハ加熱処理用治具の下面支持が、ほぼ等間隔位置の３点により行われることを特徴とする請求項６に記載された半導体ウエハ加熱処理用治具を用いた半導体ウエハ加熱処理用装置。

【請求項８】　頂板、底板及び該頂、底両板を所定間隔を隔てて連結固定する連結部材とを備え、両板間に、半導体ウエハを載置した複数の前記治具を上下多段に搭載、支持された半導体ウエハ加熱処理用装置であって、前記支持部材が、夫々の前記治具を個別に支持できるように、前記連結部材から多段に突出して設けられていることを特徴とする請求項６又は請求項７に記載された半導体ウエハ加熱処理用治具を用いた半導体ウエハ加熱処理用装置。

【請求項９】　前記連結部材が、円板状の頂底両板間に設けられた３本の柱状部材からなり、各柱状部材から前記支持部材を突出させたことを特徴とする請求項８に記

2

載された半導体ウエハ加熱処理用治具を用いた半導体ウエハ加熱処理用装置。

【請求項１０】　被処理ウエハを載置した前記治具を保持し、これを加熱処理する半導体ウエハ加熱処理用装置であって、前記支持部材が、平板状基材の上面に突出形成されたものであることを特徴とする請求項６又は請求項７に記載された半導体ウエハ加熱処理用治具を用いた半導体ウエハ加熱処理用装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、半導体ウエハ加熱処理用治具及びこれを用いた半導体ウエハ加熱処理用装置に関し、より詳細には、特定形状に形成された半導体ウエハ載置上面を有するプレート状の半導体ウエハ加熱処理用治具及びこれを用いた半導体ウエハ加熱処理用装置に関する。

【０００２】

【従来の技術】半導体デバイスの製造工程には、酸化、拡散、成膜等の種々の加熱処理プロセスがあり、半導体ウエハはこれらのプロセスで様々な加熱処理を受ける。そして、これらの処理の態様、使用する加熱手段の種類等に応じて種々の半導体ウエハ加熱処理用治具が用いられている。例えば、縦型熱処理炉を用いる半導体ウエハ熱処理工程の場合、複数枚のシリコン単結晶ウエハ等の半導体ウエハが、縦型多段のウエハ保持治具、いわゆる縦型ウエハボートに搭載保持されて処理される。この縦型ウエハボートは、例えば、図６に示すように、ウエハ１２を載置するための多数の溝（スリット）１１が設けられた棒形状の支柱部材１０が複数本（通常３本あるいは４本、図６の場合には３本）、縦方向に配列した構造となっている。

【０００３】ウエハ１２はこの複数の支柱部材１０により外周部の数点（図６の場合、３点）で支持されて熱処理される。このウエハボートの形成素材として、一般に、石英ガラス、炭化ケイ素（ＳｉＣ）コートのシリコン（Ｓｉ）含浸炭化ケイ素、単結晶シリコン、多結晶シリコン等が用いられている。

【０００４】また、エピタキシャル成長装置等によるウエハ面への薄膜気相成長工程の場合、例えば、ＳｉＣコートされた黒鉛基材から成るバッチ式や枚葉式のサセプターに半導体ウエハが載置され、所定の処理がなされる。

【０００５】

【発明が解決しようとする課題】ところで、縦型ウエハボート等の半導体ウエハ加熱処理用治具に載置された被処理ウエハには、ウエハの自重が支持部に集中するため、これにより生ずる応力が常に作用している。そして、この応力が臨界剪断応力を越えると、ウエハ内に転位が発生する。この転位は応力の作用により巨視的な大きさにまで広がり、スリップとなる。このスリップの発

生はウエハの品質を大きく低下させる。

【０００６】一般に、臨界剪断応力は高温ほどその値は小さくなり、このことは、熱処理等の高温雰囲気下では、ウエハのスリップが、常温時に比較して著しく発生し易くなることを意味している。特に、近年、半導体デバイスの高集積化に伴いウエハ一枚当たりのデバイス収率を上げるために、ウエハの大口径化が進んでいる。その結果、ウエハの自重が大きくなり、それに伴いウエハに作用する応力が増大する傾向にあり、ウエハ中にスリップがより発生し易くなってきている。

【０００７】また、上記した理由の他に、ウエハのサイズが大きくなることに起因して、特に昇温時におけるウエハ中心部と周縁部との温度差が大きくなる傾向にあり、この温度差により生じる熱応力も上記スリップ発生の原因の一つとなっている。チョクラルスキー法で製造される所謂ＣＺ－シリコンウエハは、半導体デバイスの基材として代表的なものであるが、このＣＺ－シリコンウエハの内でも、特に、格子間酸素濃度［Ｏｉ］が低い低格子間酸素濃度ＣＺ－シリコンウエハは、発生したスリップが大きくなりやすい傾向を有し、加熱処理等のウエハ処理時に大きなスリップが発生していた。

【０００８】このような、スリップ発生に基づくウエハの歩留まり低下を回避するためには、前記半導体ウエハ加熱処理用治具におけるウエハの支持点の数を増やし、一点当たりの支持荷重を減少させ、支持点での応力を前記臨界剪断応力以下に軽減させることが考えられる。

【０００９】しかしながら、半導体ウエハ加熱処理用治具におけるウエハの支持点の数を増しても、各支持点間の水平精度等の問題から、実際には、ウエハは多くとも４点程度の支点でスポット的に支えられている状態となり、上記方法では依然として応力の集中が残り、実質的解決がなされない。

【００１０】そこで、ウエハをそのほぼ全面で支持する方法、即ち、例えばウエハを、それとほぼ同径、同厚の円形プレート上に載置して支持する方法が考えられた。この方法は、可能な限り支持点を増すことを基本概念としたものである。しかし、実際のプレート面には凹凸があり、実質的に凸部のみでウエハを支持してしまい、その結果スリップの発生を完全に抑制するという目的を達成することはできなかった。また、この問題を解決する手段の一つとして、プレート板のウエハ載置面を、鏡面研磨等により該表面の凹凸がほぼ完全になくなるまで仕上げ加工し、その表面にウエハを載置する方法が考えられる。しかし、加熱処理時にウエハとプレート板が強固に密着してしまい、ウエハとプレート板を剥離させることが困難となるという新たな不都合を招来した。

【００１１】本発明者等は、従来のウエハボート等の支持治具における上記問題点を解決するために、ウエハを面で支持するための載置面の最適形状について鋭意研究を重ねた結果、下記に詳述するようにウエハ載置面を特定形状に形成したプレート状の半導体ウエハ加熱処理用治具を用いることにより上記問題が確実に解決できることを見出し、この知見に基づき本発明を完成した。また、プレート状の半導体ウエハ加熱処理用治具を搭載、支持する方法（部材）の最適形態について鋭意研究し、下記に詳述するように前記治具、及びこれを支持する部材の特定支持構造に形成した半導体ウエハ加熱処理用装置により、上記問題が確実に解決できることを見出し、この知見に基づき本発明を完成した。

【００１２】本発明は、例え大口径の半導体ウエハであっても、スリップや欠陥を発生させることなく、半導体ウエハを均質に加熱処理することができる半導体ウエハ加熱処理用治具及びこれを用いた半導体ウエハ加熱処理用装置を提供することを目的とするものである。

【００１３】

【課題を解決するための手段】本発明の半導体ウエハ加熱処理用治具は、半導体ウエハを、その上面に載置して加熱処理するプレート状の半導体ウエハ加熱処理用治具において、前記上面が、被処理ウエハの直径以上の直径の円形周縁を有すると共に、中央部に最深部を有する凹曲面形状に形成され、載置したウエハ周縁との接点位置と前記最深部との高低差が２０μｍ乃至５００μｍの範囲にあることを特徴としている。

【００１４】ここで、前記プレート状の半導体ウエハ加熱処理用治具（以下プレート状治具と略称することがある）の上面における凹曲面形状が、放物面形状又は凹球面形状に形成されていることが望ましい。また、前記プレート状治具のウエハ載置面における凹曲面形状が凹球面形状に形成され、前記凹球面形状の曲率半径（ｒ）が、載置するウエハの半径をｂ、該ウエハ周縁と載置面との接点位置から前記最深部までの高低差をａとしたとき、$r=(b^2+a^2)/2a$の関係を有することが望ましい。更に、前記プレート状治具のウエハ載置面の中心線平均粗さＲａが０．３乃至０．８μｍであることが望ましい。

【００１５】また、該プレート状治具の形状は、前記上面に対向する下面が、上面と平行する凹曲面皿形の形状のものや前記上面における前記高低差が２０μｍ乃至２００μｍの範囲にあり、上面に対向する下面が、ほぼ平面に形成されていること、いわゆる凹面・平面型形状であることが好ましい。形状が凹曲面皿形の場合は、その厚さが、１．０mm乃至１．５mmの範囲にあることが好ましく、さらにこの時の厚さの誤差範囲が±０．３mm以内であることが特に望ましい。また、凹面・平面型形状の場合は、その周縁部高さ（周縁部厚み）が１．２乃至１．５mmの範囲にあることが特に好ましい。また、前記プレート状治具のウエハ載置面に、複数の貫通孔が配設されていることが望ましく、前記貫通孔の口径が３mm乃至１０mmであること、前記貫通孔の数が３個乃至１０個であることが望ましい。

5

【００１６】更に、本発明の半導体ウエハ加熱処理用装置は、被処理ウエハを載置する上記半導体ウエハ加熱処理用治具を、単数もしくは複数搭載し、前記被処理ウエハを加熱処理するための半導体ウエハ加熱処理用装置であって、該装置が、前記治具の下面中心点から半径方向に、該半径の０．６乃至０．８倍の距離を隔てた位置で治具を支持する支持部材を具備することを特徴としている。ここで、上記半導体ウエハ加熱処理用装置は、被処理ウエハ載置治具の下面を少なくとも３点で支持することが好ましい。前記プレート状治具を底面で支持する少なくとも３点がほぼ等間隔に位置することが特に望ましい。

【００１７】また、前記半導体ウエハ加熱処理用装置が、頂板、底板及び該頂、底両板を所定間隔を隔てて連結固定する連結部材とを備え、両板間に、半導体ウエハを載置した複数の前記治具を上下多段に搭載、支持された半導体ウエハ加熱処理用装置であって、前記支持部材が、夫々の前記治具を個別に支持できるように、前記連結部材から多段に突出して設けられている半導体ウエハ加熱処理用装置であることが好ましい。また、前記縦型ウエハボート形式の半導体ウエハ加熱処理用装置における前記連結部材が、円板状の頂底両板間に設けられた３本の柱状部材からなり、各柱状部材から前記支持部材を突出させたものであることが特に好ましい。更に、前記半導体ウエハ加熱処理用装置が、被処理ウエハを載置した前記治具を保持し、これを加熱処理する半導体ウエハ加熱処理用装置であって、前記支持部材が、平板状基材の上面に突出形成された半導体ウエハ加熱処理用装置、即ち、所謂、バッチ式または枚葉式半導体ウエハ処理装置用のサセプターであることが望ましい。

【００１８】本発明にかかる半導体ウエハ加熱処理用のプレート状治具は、ウエハを面で支持するために最適なウエハ載置面、即ち、載置ウエハの直径以上の直径を有すると共に中央部に最深部を有する凹曲面形状に形成され、かつ載置ウエハ周縁との接点位置から最深部までの高低差が２０乃至５００μmの範囲にあるという特定ウエハ載置面を有するウエハ載置用プレートであることが顕著な特徴である。

【００１９】例えば、周縁が円形の放物面形状または凹球面形状等の特定凹曲面形状載置面で、ウエハを支持した場合、初めにウエハの周縁部と該載置面とが接触する。そして、載置されたウエハは、自重により撓んでその中央部は僅かに沈むことにより載置面中央部とも接するようになる。これによって、ウエハが載置面周辺部と中央部の両方で同時に支持され、応力の集中を緩和することができる。

【００２０】上記のようなウエハ支持態様の場合、ウエハは広範囲で支持されるため、スリップは発生しない。即ち、本発明においては、ウエハ載置用プレート状治具の載置面が凹曲面形状に形成されること及びウエハ載置

6

面の中央部（最深部）と載置面周辺部のウエハ周縁接触位置との高さの差が２０乃至５００μmの範囲にあることが特に重要である。この差が５００μmを越えるとウエハが撓んでもウエハの中央部が載置面にまで達することができないため周縁部のみの支持となり、そこからスリップが発生しやすい。また、この差が２０μm未満ではウエハの中央部のみ、あるいはウエハの中央部と特定の一部を支持することになり、そこからスリップが発生する。

【００２１】また、本発明の半導体ウエハ加熱処理用治具において、前記プレート状治具の載置面の中心線平均粗さＲａ（ＪＩＳ　Ｂ０６０１－１９９４）を０．３乃至０．８μmの範囲にすることによって、上記スリップ発生をより確実に防止することができ、また加熱処理時にウエハとプレートとが密着せず、容易にウエハを剥離させることができる。また、粗度をこの範囲とすることにより、剥離時にウエハが破壊するのを防止することが出来る。

【００２２】また、プレート状治具の載置面に、口径が３乃至１０mm程度の貫通孔を、３乃至１０個、配設した態様のものは、加熱処理時に載置ウエハとプレートの間隙が真空状態となることによって、生ずる両者の密着を防止する利点を有する。

【００２３】更に、前記プレート状治具の少なくとも載置面が、シリコン（Ｓｉ）からなる態様の治具の場合には、特に載置ウエハがシリコンウエハの場合、ウエハと熱膨張率や硬度等の物性が同一であるためウエハを傷つけたりすることがなく、また、特に単結晶シリコンの場合には、高純度であり、汚染の問題がない。またプレート状治具の上面に対向する下面が上面と平行な凹曲面形状を有し、該プレート材の厚さが、１．０乃至１．５mmの範囲にあるものは、上記利点の他に、プレート上にウエハを載置して加熱した場合にも変形等を起こすことなく充分な支持強度を有する。特に、熱容量も過大でないため熱伝達も速く、加熱時にウエハを温度ムラなく均一に昇温させることができるため、温度歪みに基づくウエハのスリップ発生を抑制できる。一方、プレート治具の上面における高低差が２０μm乃至２００μmの範囲にあり、下面がほぼ平面に形成されたものにあっては、熱伝達の不均一性から高低差を比較的小さく（２００μm）に抑える必要がある。

【００２４】更にまた、前記プレート状治具及びその底面において支持部材により、少なくとも３点で支持する半導体ウエハ加熱処理用装置で、前記３支持点が、プレート状治具の下面中心から半径方向に該半径の０．６乃至０．８倍の距離隔たって位置する半導体ウエハ加熱処理用装置は、従来しばしば生じた載置ウエハの外周部での波状変形を抑制できる利点を有する。プレート状治具の下面中心から半径方向に該半径の０．６倍未満の場合には、支持部分が突起状となって、この部分のみの支持

となってウエハにスリップが発生しやすくなる。一方、プレート状治具の下面中心から半径方向に該半径の０．８倍を越えた場合には、該プレートが撓みすぎ、主にウエハ周辺のみの支持となってスリップが発生しやすくなる。また、半導体ウエハ加熱処理用装置が、いわゆる縦型ウエハボート形式のものである場合は、ウエハ載置プレート治具を多段に搭載することができ、一度に多数のウエハをスリップ等の欠陥を生じさせることなく良好に加熱処理することができる。またプレート状治具は、バッチ式あるいは枚葉式サセプターにも適用することができる。

【００２５】本発明の半導体ウエハ加熱処理用のプレート状治具は、特に、加熱処理時等においてスリップが発生しやすいといわれている低格子間酸素濃度シリコンウエハの加熱処理用に有効に適用できる。

【００２６】

【発明の実施の形態】以下本発明を、図に基づいて詳細に説明する。図１は、本発明にかかるプレート状治具の一実施形態を誇張して示した斜視図であり、図２（ａ）、（ｂ）は、図１のプレート状治具に被処理ウエハを載置した状態を示した図であって、（ａ）は載置直後のウエハの状態を示す断面図であり、（ｂ）は加熱中のウエハの状態変化を示す断面図である。図３は、本発明のプレート状治具の他の一実施形態を誇張して示した斜視図である。図４は、加熱処理すべき半導体ウエハを載置した本発明のプレート状治具を多段搭載、支持した、本発明にかかる半導体ウエハ加熱処理用装置を炉内に収容した態様で示した図である。図５（ａ）、（ｂ）は、単数のプレート状治具を３本の支持部材によって支持した枚葉式の、本発明にかかる半導体ウエハ加熱処理用装置を炉内に収容した態様で示し、（ａ）は、その側面図を、（ｂ）は平面図を示す。また図６は、半導体ウエハを支持する従来の縦型ウエハボートを示す。更に、図７は本発明のプレート状治具の多段搭載支持する、本発明にかかる半導体ウエハ加熱処理装置を構成する支持具を示した斜視図、図８は単数のプレート状治具をリング状の支持部材によって支持した枚葉式の、本発明にかかる半導体ウエハ熱処理装置を示した断面図、図９は図８に示した該装置の平面図、図１０はリング状の支持部材を馬蹄形状とした本発明にかかる半導体ウエハ加熱処理装置である。

【００２７】本発明の半導体ウエハ加熱処理用のプレート状治具は、図１、図２に示すように、そのウエハ載置面（上面）が、載置される被処理ウエハの直径２ｂ（半径ｂ）以上の周縁直径Ｄを有すると共に、中央部に最深部を有する凹曲面形状に形成され、かつ載置ウエハ周縁との接点位置から前記最深部までの高低差ａが２０乃至５００μｍの範囲となるように形成される。

【００２８】このウエハ載置面に被処理ウエハを載置すると、図２（ａ）に示すように、ウエハ１はその周縁部で載置面と接触して支持されこの状態で加熱処理を行うと、中央部はその自重により僅かに撓んで周縁部より沈み、その中央部がプレート状治具２の最深部である中央部に接し、この凹曲面全体で支持される（図２（ｂ））。

【００２９】ウエハは、熱処理装置内で加熱された場合、下面側と上面側の両方から熱を受ける。その熱量は、通常、下面側が若干多いため、これによる熱膨張差により、ウエハの周辺部が極僅かではあるが上方に反る傾向がある。前記プレート状治具２による凹曲面の支持は、前記ウエハのこのような性質を利用したものである。

【００３０】本発明のプレート状治具２のウエハ載置面は、上記したウエハの加熱処理時における自然変形に適合した形状に形成したものである。該ウエハ載置面の形状は、上記の目的から、中央部に最深部を有する凹曲面形状であれば、特に限定されるものではない。例えば、任意の凹曲面形状に形成されて差し支えないが、凹曲面が放物線を回転して形成される放物面形状、円を回転して形成される凹球面形状等であっても良い。

【００３１】特に好ましい凹曲面形状は、図２（ａ）に示すように、その曲率半径（ｒ）が、載置ウエハの半径をｂ、該ウエハ周縁の載置面との接点位置から載置面最凹点までの高低差をａとしたとき、

$$r = (b^2 + a^2) / 2a$$

の関係を有する凹球面状に形成されたものである。

【００３２】本発明では、上記ウエハ載置面の凹曲面形状において、載置ウエハ周縁との接点位置から最深部までの高低差が、２０乃至５００μｍ、より好ましくは５０乃至３５０μｍ、の範囲にあるように形状設定することが重要である。この高低差が５００μｍを越える場合は、ウエハの中央部が前記載置面の最深部である中央部に届かず、実質的にウエハ周辺部のみの支持となり、本発明の目的であるウエハのスリップ発生を充分に防止することができない。一方、高低差が２０μｍを下回る場合は、ウエハの加熱時の反りが高低差を上回る場合が生じ、ウエハ中央部のみ、または、中央部と周辺部局所点のみでの支持となり、この場合も、本発明の目的を充分に達成することができない。なお、前記ウエハ載置面が曲率半径$r = (b^2 + a^2) / 2a$の関係を有する凹球面状に形成された場合、被処理ウエハ１２インチ径（３００ｍｍ）で、曲率半径は、５６．２５乃至５６２．５ｍとなる。

【００３３】本発明の前記プレート状治具の載置面（上面）において載置ウエハと接する部分は、その表面粗さである中心線平均粗さＲａ（ＪＩＳ　Ｂ０６０１－１９９４）が０．３乃至０．８μｍの範囲に形成されることが好ましい。中心線平均粗さが０．３μｍを下回る場合は、加熱処理時にウエハと載置面とが密着する傾向があり、ウエハをプレート状治具から剥離させることが困難

となる。中心線平均粗さが、０．８μｍを越える場合は、ウエハの載置面接触部での支持が、粗面の凸点のみの支持となり、スリップ発生の誘因となる。

【００３４】また、図示しないが、本発明のプレート状治具のウエハ載置面に、口径が３乃至１０ｍｍ、特に好ましくは５乃至８ｍｍの貫通孔を、３乃至１０個、特に好ましくは４乃至７個、面内に均一に分布して配設することが好ましい。上記の貫通孔を設けた態様のプレート状治具は、加熱処理時に載置ウエハとプレートの間隙が真空状態となることにより生ずる両者の密着を防止することができる。

【００３５】前記貫通孔３の孔径が１０ｍｍより大きい場合や孔数が１０個より多い場合は、プレート状治具自体の強度低下やウエハ加熱時の温度むらの増大を招き易くなる。また、ウエハ載置面に貫通孔が不均一に配置された場合は、プレート状治具の強度低下を招き、貫通孔がウエハ面の動径方向の同一直線上に３点以上並ぶ態様に配設された場合も同様にプレート状治具の強度低下を招く。これは、穴が、同一直線上に並ぶとその領域で断面積が小さくなり、同じ力が作用する場合、断面積が小さくなるため応力は大きくなる。撓みは、応力に比例するので、結局上記の条件では大きく撓むことになる。

【００３６】本発明で用いる上記プレート状治具の、ウエハ載置面以外の形状は、本発明の半導体ウエハ加熱処理用装置に搭載可能な形状であれば特に限定されるものではなく、該プレートを搭載する装置構造に合わせて適宜設定して良い。このようなプレート状治具の外形形状として、例えば図１に示したような凹曲面皿形形状（カップ形状）のプレート治具２や、図３に示したような上面に凹曲面形状が形成され底面が平らな凹面・平面型形状のウエハ載置用プレート等を例示することができる。

【００３７】加熱処理時にウエハを温度ムラなく均一に加熱昇温する観点からは、構成材がプレート全体でほぼ等しい適正断面厚ｔを有し、熱容量が過大でないカップ形状（皿形）のプレート治具２が好ましい。凹面・平面型形状の治具（図３に示した治具）の場合は、治具の周縁部と中奥部ではその厚さの相違に基づく熱容量の差が若干有るため、これに半導体ウエハを載置し熱処理した際に、ウエハの面内温度分布に多少の不均一性を生ずる可能性がある。このため、上記凹面・平面型形状のプレート状治具（図３に示した治具）の場合には、治具上面の凹曲面形状を、載置ウエハ周縁の接点位置と最深部との高低差が２０乃至２００μｍとなるように形成し、且つ、該治具の周縁部高さ（厚さ）を１．２乃至１．５ｍｍ、即ち、変形を防止するため治具中央部肉の厚さが１ｍｍ以上となるように形成することが好ましい。また、プレート状治具を構成する材料としては、通常この種の治具に用いられる材料、例えば、石英ガラス、炭化ケイ素（ＳｉＣ）コートのシリコン（Ｓｉ）含浸炭化ケイ素、単結晶シリコン、多結晶シリコン、ＣＶＤ－ＳｉＣ膜材等を挙げることができる。これらの内では、シリコンが好ましく、特に単結晶シリコンが好ましい。特に、被処理半導体ウエハがシリコンウエハである場合には、プレート状治具２の、少なくともウエハ載置面部分はシリコン単結晶で形成されていることが、熱膨張率や硬度等の物性が同一であるためウエハを傷つけたりすることがなく、また、汚染させたりすることがなく好ましい。なお、熱膨張率の観点からは特に、シリコン単結晶単体であることが最も好ましい。

【００３８】また図２に示したプレート状治具２は、特にその形成材料がシリコンからなる場合、プレート材の断面厚さｔは１．０乃至１．５ｍｍの範囲にあることが好ましい。プレート状治具の厚さが、１．０ｍｍを下回る場合は、プレート状治具２を縦型ウエハボート形式の支持具で支持した際、支持された部分及びその周辺が盛り上がり、前記ウエハ載置面に局所的な凹凸を生じさせる。その結果、前記凹凸が載置したウエハと接し、ウエハにスリップを発生させる。一方、厚さが１．５ｍｍを越える場合には、プレート状治具の熱容量が大きくなり、ウエハの面内温度不均一化が生じやすくなる。なお、上記プレート治具が、例えば、図３に示した凹面・平面型形状のプレート治具２の場合は、その最薄部即ち面中央部の厚さｔを上記の断面厚さとする。

【００３９】被処理ウエハを載置したプレート状治具は、所定の支持部材を有する支持具で支持され、本発明の半導体ウエハ加熱処理用装置を構成して、該装置内に収容される。本発明において、プレート状治具を収容する支持具は、該プレート状治具を支持する支持手段を備えた装置であれば特に限定されるものではなく、ウエハの処理目的に応じて適宜選択されて良い。

【００４０】例えば、エピタキシャル成長装置等の処理装置の場合には、図５（ａ）、（ｂ）に示すような突起状支持部材４ａ上で支持されたウエハ載置用プレート治具２をベルジャー４ｂ内に収容するサセプター４を挙げることができる。即ち、サセプター４の上には３つの突起状のプレート支持部材４ａが設けられ、そのプレート支持部材４ａの上に図１に示したカップ型（皿型）のプレート治具２が載せられる。前記突起４ａはウエハ載置用プレート治具２の中心に対して対象に１２０°の間隔をもって形成されている。

【００４１】一方、縦型ウエハボートのような複数のウエハを多段に搭載する形式の支持治具を具備する半導体ウエハ加熱処理用装置の場合は、例えば、図４に示したようなプレート状治具の支持手段を多段に備えたものを例示することができる。図４に示した縦型ウエハボート状の支持具５は、この支柱（連結部材）５ａから突出した広幅のプレート支持部材５ｂを備えている。前記プレート状治具が、前記プレート支持部材５ｂに多段載置される。なお、図４は縦型の熱処理炉の側面断面図であって、図中６は炉芯管、７はヒータを示している。

【００４２】プレート状治具を、支持具のプレート支持部で支持する場合は、その底面において、プレート状治具２の中心に対称な少なくとも３点で支持されることが好ましく、特に該３支持点が、ウエハ載置プレート状治具の中心から半径方向に該半径の０．６乃至０．８倍の距離隔たって位置することが好ましい。上記のようにプレート状治具を支持することにより、従来、半導体ウエハ加熱処理用治具において、ウエハ載置用プレートの外周部での波状変形の発生を抑制できる。

【００４３】また、前記したように図４に示された突起状支持部材５ｂに替えて、図７に示すようなリング状の支持部材５ｃとしても良く、また前記リング状の支持部材５ｃの一部を切欠いた馬蹄形状に支持部材を形成しても良い。なお、前記リング状の支持部材は、図８、９に示すような枚葉式の熱処理装置用にも適用することができる。すなわち、基体８の上面にリング状の支持部材８ａを設け、プレート状治具２を載置しても良い。図８は図９のＡ－Ａ断面図であり、図９は平面図である。また、図１０（ａ）、（ｂ）に示すように、前記リング状の支持部材８ａの一部を切欠いた馬蹄形状に支持部材を形成しても良い。このとき、図１０（ａ）に示すようにその切欠き部分の大きさは、その中心角θが３０°以下が好ましい。これはウエハ面内に対して温度が不均一にならないようにするためであり、前記３０°が最大値であり、より好ましくは１０°以下が良い。

【００４４】また前記したように支持部材の形状は、特に限定されるものではないが、該治具が当接する支持部材の熱容量は、可能な限り小さいことが好ましいため、支持部材は円形断面の棒状形状が好ましく、プレート治具と支持部材は点接触となるようになすのが好ましい。支持点数は３点以上でも構わないが、縦形ボート形式の場合、棒状の連結部材の本数をその分だけ増やす必要があり、コストの増大を招くため、３本が好ましい。また枚葉式の場合においても３点以上の支持点を設けても良いが、支持部材あるいは平板状の寸法精度上、結局３点支持となるため、３点支持が好ましい。

【００４５】また、単結晶シリコンインゴットから作製される単結晶シリコンウエハは、半導体デバイスの基材として代表的なものであるが、このシリコンウエハの内でも、特に、格子間酸素濃度［Ｏｉ］が低い低格子間酸素濃度ＣＺ－シリコンウエハ（通常［Ｏｉ］濃度が１．３×１０^{18} atoms/cm^3 (old ASTM) 以下）は、加熱処理等のウエハ処理時に、特にスリップ発生し易く、また発生したスリップが大きくなり易い傾向を有することが知られている。本発明の半導体ウエハ加熱処理用のプレート状治具は、このような低格子間酸素濃度ＣＺ－シリコンウエハの加熱処理用に特に有効に適用できる。

【００４６】

【実施例】「実施例１」シリコン単結晶インゴットから切り出した後、グラインダーによる研磨加工及びエッチング加工により、周縁が円形、中央部に最深部を有する凹球曲面形状のウエハ載置面（上面）を備え、下面が平面の図３に示すような凹面・平面型形状のプレート状治具を作製し、このプレート状治具をアンモニア水と過酸化水素から成る洗浄水を用いて洗浄した。なお、該プレート状治具のウエハ載置面（上面）の直径は３０３ｍｍ、ウエハ周縁との接点位置から最深部までの高低差は２０μｍ、ウエハ載置面の中心線平均粗さＲａ０．５μｍ、治具の周縁部厚さ１．２ｍｍであった。また、ウエハ載置面には、その中心及び半径の０．６５倍の位置に６０°間隔で６個、すなわち、合計で７個の貫通孔を形成した。次に示すサンプルウエハを用意し、上記プレート状治具の載置面（上面）上に図３（ｂ）に示す状態に載置した。サンプルウエハとしては、直径３００ｍｍ、面方位［１００］、Ｐ型、抵抗ρ＝９～１４Ω・ｃｍのシリコン単結晶ウエハを用いた。なお、このサンプルウエハは、赤外吸収法により事前に測定した格子間酸素［Ｏｉ］濃度が、１．１～１．２×１０^{18} atoms/cm^3 (old ASTM) であった。

【００４７】上記サンプルウエハを載置したプレート状治具２５個を縦方向多段に支持する支持具（縦型ウエハボート）に搭載した。また、この支持治具の上下端部には各々３枚づつダミーウエハを載置した。前記支持治具は、図４に示したものと同等であり、シリコン製で３点支持式のものを用いた。なお、この支持治具は、ウエハを載置した前記プレート状治具の底面部を中心から半径の０．８倍の位置で該中心に対称に３点で支持するようにスリット（支持部材）が長く形成されている。

【００４８】上記サンプルウエハ載置プレート状治具を上記支持具に搭載した半導体ウエハ加熱処理用装置を用いてウエハの熱処理を行い、その際のスリップ発生状況の評価を実施した。なお、熱処理は、７００℃で炉入れした後、８℃／ｍｉｎで１０００℃迄昇温し、その後、２℃／ｍｉｎで１２００℃迄昇温、この１２００℃の状態で１時間保持し、２℃／ｍｉｎで１０００℃迄降温し、その後８℃／ｍｉｎで７００℃迄降温し、炉出しするシーケンスで行った。なお、炉内に水素ガスを２０１／ｍｉｎで流入させ、水素雰囲気とした。上記熱処理後のサンプルウエハのスリップ発生状態を、Ｘ－線トポグラフィー（ｌａｎｇ法）を用いて、測定評価した。なお、Ｘ－線ターゲットには、Ｍｏを用い、加速電圧５５ｋＶ、電流２９０ｍＡの操作条件で、２５枚すべてについて測定を実施した。回折面はスリップ観察に最も適している４００回折とした。その評価結果を表１及び図１１に示す。なお、いずれの場合もスリップの位置に多少の違いがあるが、２５枚のほとんどが同様なスリップ発生状況であったため、その一例を図１１に示した。

【００４９】「実施例２、３」ウエハ載置面におけるウエハ周縁との接点位置から最深部までの高低差が１４０μｍ（実施例２）、２００μｍ（実施例３）であり、周

縁部厚さが１．３ｍｍ（実施例２）、１．５ｍｍ（実施例３）である以外は実施例１と同様に作製したプレート状治具を用い、実施例１と同様の縦型ウエハボート形式の支持具に、実施例１と同様にしてプレート状治具を載置し、実施例１と同様に熱処理した後、ウエハのスリップ発生状態を測定評価した。その評価結果を表１及び図１１に示す。

【００５０】「比較例１」実施例１で使用したと同様のシリコン単結晶インゴットから切り出し、グラインダーによる研磨加工及びエッチング加工により、上、下面が互いに平行平面の円盤状ウエハ載置用プレート状治具（厚さ０．９ｍｍ、上面中心線平均粗さＲａ０．５μｍ）を製作し、これを実施例１と同様の支持具に、実施例１と同様にして載置し、実施例１と同様に熱処理した後、ウエハのスリップ発生状態を測定評価した。その結果を表１及び図１１に示す。

【００５１】「比較例２」ウエハ載置面におけるウエハ周縁との接点位置から最深部までの高低差が２２０μｍ、周縁部厚さ１．７ｍｍである以外は実施例１と同様に作製したプレート状治具を用い、実施例１と同様の支持具に、実施例１と同様に搭載し、同様に熱処理した後、ウエハのスリップ発生状態を測定評価した。その評価結果を表１及び図１１に示す。

【００５２】「実施例４」実施例１と同様のシリコン単結晶インゴットから、周縁が円形、中央部に最深部を有する凹曲面形状の上面を備え、該上面に平行する湾曲凹面状下面を有する凹曲面皿形形状のプレート状治具を作製し、この治具をアンモニア水と過酸化水素からなる洗浄水を用いて洗浄した。なお、該プレート状治具の上面（ウエハ載置面）の直径は３０３ｍｍ、ウエハ周縁との接点位置から最深部までの高低差は２０μｍ、ウエハ載置面の中心線平均粗さＲａ０．５μｍ、厚さ１．０ｍｍであった。このプレート状治具を用い、実施例１と同様の支持具に、治具底面部を中心から半径の０．６倍の位置で対称３点支持した以外は実施例１と同様にして載置し、実施例１と同様に熱処理した後、ウエハのスリップ発生状態を測定評価した。その評価結果を表１及び図１１に示す。

【００５３】「実施例５、６」高低差、厚さ、上面中心平均粗さＲａが夫々表１に記載した値である以外は実施例４と同様の凹曲面皿形プレート状治具を作製し、これを実施例４と同様にしてウエハのスリップ発生状態を測定評価した。その評価結果を表１及び図１１に示す。

【００５４】「比較例３乃至７」高低差、厚さ、上面中心線平均粗さＲａが夫々表１に記載した値である以外は実施例４と同様の凹曲面皿形プレート状治具を作製し、縦型ウエハボート形式の治具搭載装置に、治具底面部を中心から夫々表１に記載した半径の倍数位置で支持した以外は実施例４と同様にして載置し（ただし、比較例５のみは４点対称支持）、実施例４と同様に熱処理した後、ウエハのスリップ発生状態を測定評価した。その評価結果を表１及び図１１に示す。

【００５５】「比較例８」周縁部厚さ１．０ｍｍである以外は実施例１と同様に作製したプレート状治具を用い、実施例１と同様の支持具に、治具底面部を中心から半径の０．６倍の位置で対称３点支持した以外は実施例１と同様にして載置し、実施例１と同様に熱処理した後、ウエハのスリップ発生状態を測定評価した。その評価結果を表１及び図１１に示す。

【００５６】

【表１】

15　　16

	支持方式		下面形状	高低差（μm）	厚さ（mm）	Ｒａ（μm）	スリップ発生状況
	支持点数	支持位置					
比較例１	３	０．８	平面	０（フラット）	０．９	０．５	図７比１
実施例１	３	０．８	平面	２０	１．２	０．５	図７実１
実施例２	３	０．８	平面	１４０	１．３	０．５	図７実２
実施例３	３	０．８	平面	２００	１．５	０．５	図７実３
比較例２	３	０．８	平面	２２０	１．７	０．５	図７比２
実施例４	３	０．６	湾曲面	２０	１．０	０．５	図７実４
実施例５	３	０．６	湾曲面	３５０	１．３	０．５	図７実５
実施例６	３	０．６	湾曲面	５００	１．５	０．５	図７実６
比較例３	３	０．６	湾曲面	５５０	１．８	０．５	図７比３
比較例４	３	０．５	湾曲面	３５０	１．３	０．５	図７比４
比較例５	４	１	湾曲面	３５０	１．３	０．５	図７比５
比較例６	３	０．６	湾曲面	３５０	１．３	０．１	図７比６
比較例７	３	０．６	湾曲面	３５０	１．３	１．０	図７比７
比較例８	３	０．６	平面	０（フラット）	１．０	０．５	図７比８

【００５７】図１１から明らかなように、実施例例１～３では、被処理ウエハ２５枚中１０～１３枚において、ウエハの周辺部に１～２本のスリップが観察された。しかしながら、１０mm以上のスリップはまったく観察されなかった。なお、残りの被処理ウエハのいずれにもスリップはまったく観察されなかった。また、実施例４～５では、２５枚の被処理ウエハのすべてについて、スリップはまったく観察されなかった。一方、比較例１～５、７、８では、ウエハの周辺部において１０mm以上のスリップが高密度に存在する部分が、数か所観察された。また比較例６ではウエハの略直径方向にへき開が観察された。以上のように、実施例においては、特定形状のウエハ載置面を備え、これに被処理ウエハを載置して加熱処理するため、ウエハ内にスリップ等の欠陥の発生を防止でき、あるいは抑制できることが認められた。

【００５８】

【発明の効果】本発明の半導体ウエハ加熱処理用治具は、上述した特定形状のウエハ載置面を備え、これに被処理ウエハを載置して加熱処理するため、例え大口径のウエハを高温熱処理する場合においてもウエハ内にスリップ等の欠陥を発生させることがなく、良好な品質の半導体デバイスを安定して歩留まり良く製造することができる。

【図面の簡単な説明】

【図１】図１は、本発明にかかる半導体ウエハ加熱処理用治具の一実施形態を示す斜視図である。

【図２】図２は、図１の半導体ウエハ加熱処理用治具にウエハを載置した状態を示す図、（ａ）は加熱前の状態を示す断面図、（ｂ）は加熱処理状態におけるウエハ状態を示す断面図である。

【図３】図３は、本発明にかかる半導体ウエハ加熱処理用治具の他の一実施形態を示す斜視図である。

【図４】図４は、本発明にかかる半導体ウエハ加熱処理用装置を炉内に収容した状態を示した図である。

【図５】図５は、本発明にかかる単数のプレート状治具（半導体ウエハ加熱処理用治具）を支持した枚葉式の、本発明にかかる半導体ウエハ加熱処理用装置を炉内に収容した態様を示す図であって、（ａ）は側面図、（ｂ）は平面図である。

【図６】図６は、半導体ウエハを支持する従来の縦型ウエハボートを示す図である。

【図７】図７は、本発明のプレート状治具（半導体ウエハ加熱処理用治具）を多段搭載支持する支持具を示した斜視図である。

【図８】図８は、単数のプレート状治具をリング状の支持部材によって支持した枚葉式の、本発明にかかる半導体ウエハ加熱処理用装置を示す図９のＡ－Ａ断面図である。

【図９】図９は、図８に示す半導体ウエハ加熱処理用装置の平面図である。

【図１０】図１０は、図８、図９に示したリング状の支持部材を馬蹄形状とした半導体ウエハ加熱処理用装置である。

【図１１】図１１は、実施例・比較例における、熱処理後のサンプルウエハのｘ－線トポグラフによる状態観察図である。

【符号の説明】

１　ウエハ
２　プレート状治具
４　支持具（サセプター）

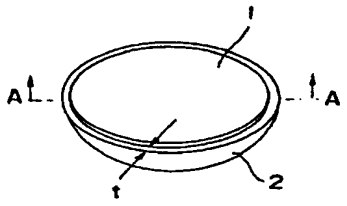
17

4 a　突起状支持部材
4 b　ベルジャー
5　支持具（縦型ウエハボート）
5 a　連結部材（支柱）
5 b　支持部材
5 c　支持部材
6　炉心管

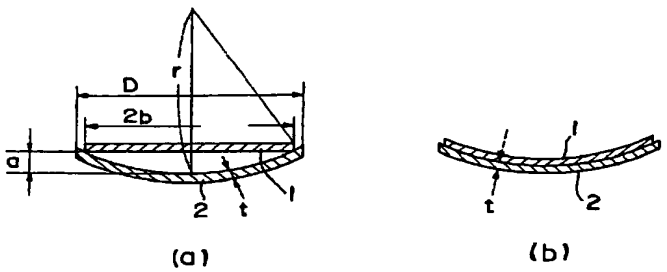
18

7　ヒータ
8　基体
8 a　支持部材
１０　連結部材（支柱）
１１　溝（スリット）
１２　ウエハ

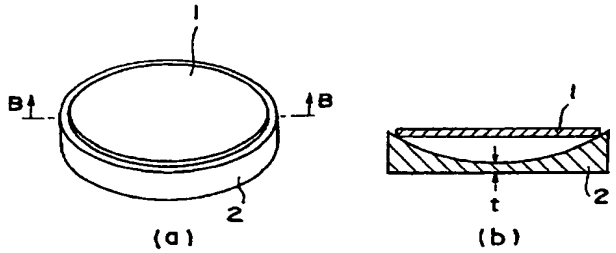
【図１】



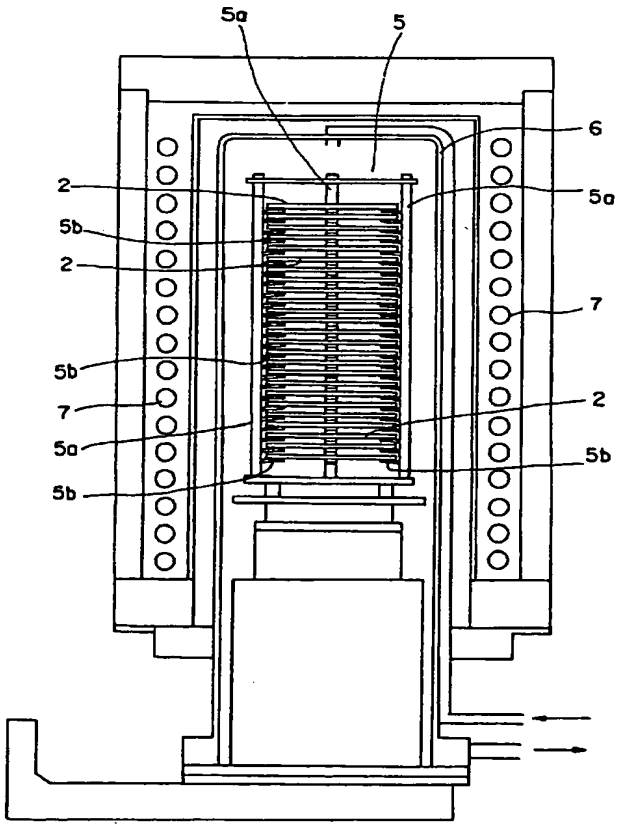
【図２】



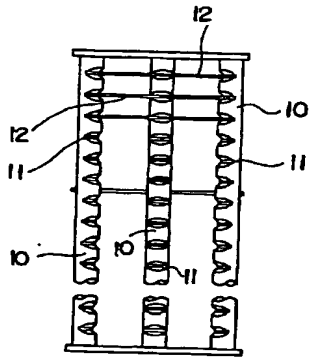
【図３】



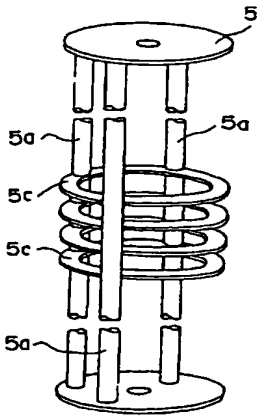
【図４】



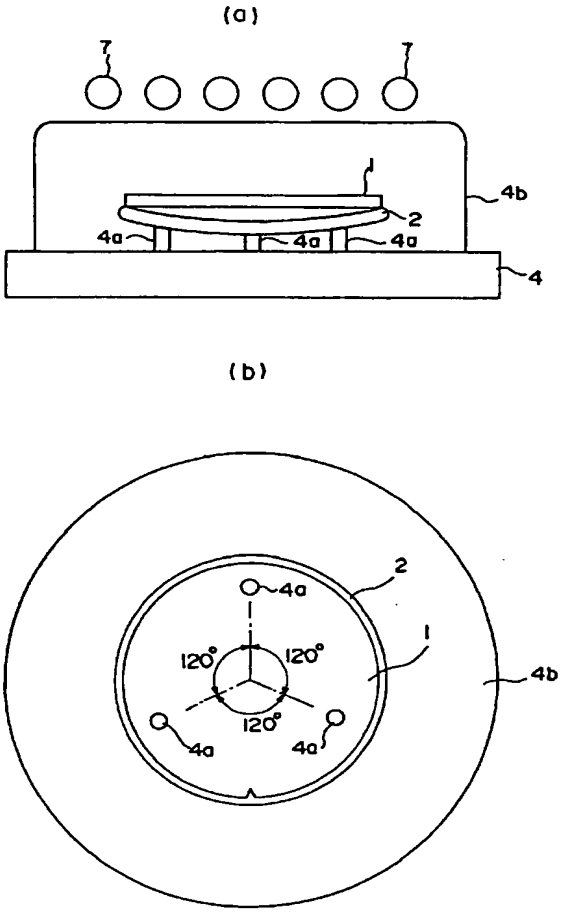
【図６】



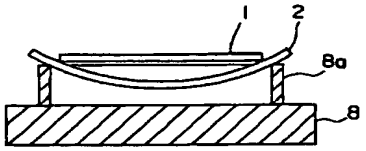
【図７】



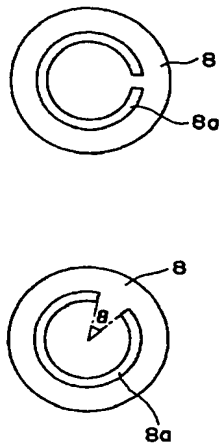
【図５】



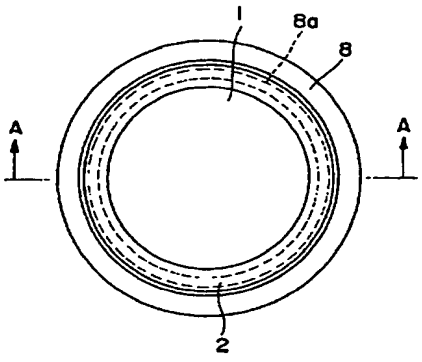
【図８】



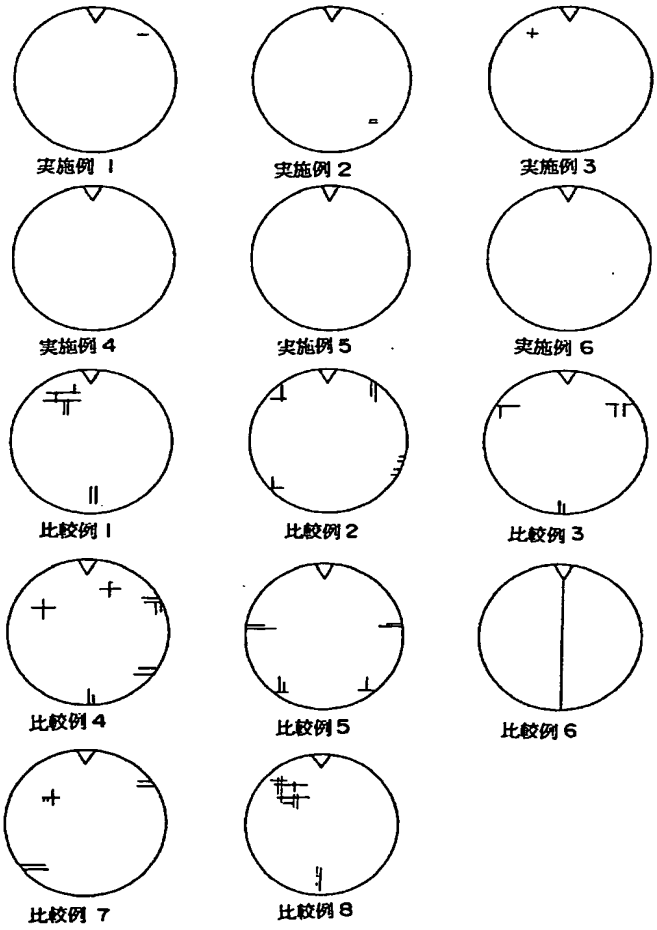
【図１０】



【図９】



【図１１】



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